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SURGERY

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A TREATISE FOR STUDENTS AND PRACTITIONERS

BY

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TO THE

STUDENTS OF ST GEORGE'S HOSPITAL

WITH WHOM HE HAS SPENT A CONSIDERABLE
PORTION OF HIS LIFE

AND SOME OF HIS HAPPIEST DAYS

THIS WORK IS DEDICATED

BY THEIR SINCERE FRIEND

THE AUTHOR

PREFACE

THIS book is the substance of the Lectures on Surgery which I delivered at St. George's Hospital for fifteen years—modified, of course, from time to time in accordance with the advances made in the Science and Art of Surgery.

I trust that these Lectures were of some use to my pupils, and I feel justified in thinking that they were, for I have been constantly asked to publish them. I have determined to do so, now that I can no longer teach by word of mouth, in the hope that, though debarred by lapse of time from taking any active part in teaching Medical Students, I may still be of some service to them, and that this work may assist them in their study of the Principles and Practice of Surgery.

The book has been written mainly for Students, but I hope that Practitioners will find it a useful work of reference, containing a concise and practical account of the causes of surgical injuries and diseases, the signs by which they may be recognised, and the appropriate treatment to be adopted for their cure.

The work may be regarded as the outcome of the experience of a Hospital Surgeon and Teacher for nearly thirty years. In writing it, I have been compelled, on account of the exigencies of space, to be to a certain extent dogmatic, and to state my own views of the nature of the various injuries and diseases that I discuss, with little or no allusion to contrary opinions which are held by others. This is especially so with regard to treatment. For the most part I have only described the treatment which, in my experience, has proved most beneficial, and have merely incidentally alluded to other plans, or have omitted them altogether ;

for it was found impossible, if the work was to be kept within the limits determined upon, to allude to all the plans of treatment which have been recommended at different times for different diseases.

Most of the illustrations have been drawn by DR. HARVEY GOLDSMITH, one of my former pupils ; some from preparations or drawings in the Museum of St. George's Hospital, which I have been accustomed to use in order to illustrate my subject ; others from rough sketches made by myself, such as I have been in the habit of drawing on the blackboard during the delivery of my lectures. I feel that my best thanks are due to DR. GOLDSMITH for the great pains he has bestowed on his work, and for the artistic finish which he has given to my crude sketches. Some few illustrations have been borrowed from other sources, and these have been acknowledged in the text.

My best thanks are also due to my friend MR. C. R. KEYSER, Demonstrator of Anatomy at St. George's Hospital, and to my son, MR. LAWRENCE PICK, for assistance in correcting the proofs, and for many valuable suggestions made by them in passing these pages through the press.

T. PICKERING PICK.

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SURGERY

SECTION I

INFLAMMATION

In commencing a study of the Art and Science of Surgery, it is necessary to describe **Inflammation,** which is at the root of and underlies most surgical processes. A right understanding of it is, therefore, necessary in order to clear the ground and enable us to appreciate the various pathological changes which take place in the several diseases which we shall have to describe.

In considering the subject of inflammation, the first thing necessary is to have a clear and logical understanding of what inflammation is. The definition which is most usually accepted is that proposed by Sir John Burdon Sanderson: that 'inflammation is the succession of changes which occur in a living tissue when it is injured, provided that the injury is not of such a degree as at once to destroy its structure and vitality.' Or, in other words, more briefly and succinctly, it is 'the response of living tissue to injury.'

By this he means, that whenever an injury is inflicted on any part of the living body a series of changes takes place in the part, and these changes, up to a certain point—that is to say, as long as a destructive process is going on—constitute inflammation. The further changes which take place are those of *repair*, and are not inflammatory. Inflammation must therefore be regarded as essentially a destructive process, and precedes repair, which is more or less a constructive process; and the one must not be confounded with the other.

The older definition of inflammation was that it was that condition which was attended by certain so-called cardinal symptoms—pain, heat, redness, and swelling—and it was said that we must regard these symptoms as the 'characteristic of the *thing* of which the word inflammation is the *name*' (Burdon Sanderson). But I shall have occasion to point out immediately that we are not in a position to say that a part is inflamed because of the presence of these four symptoms, for I shall have to describe a condition in which they may all be present and which certainly is not inflammation.

If we do not accept Burdon Sanderson's definition of inflammation, as some do not, the difficulty is great in giving a clear, logical definition to this condition, although we easily recognise the combination of processes which are taking place in the tissues. I should regard inflammation as a modification of the normal physiological processes in the various tissues of the body, resulting from the application of some irritant, mechanical or chemical, to the part—or, as Virchow terms it, 'a disorder of nutrition'—the process in many instances being followed by the formation of a new material of a less highly organised nature than the original tissue in which the inflammation has taken place.

Inflammation is attended by a local disturbance of the circulation, with, in the first instance, an increased flow of blood into and through the part. There are, however, other conditions in which there is also this same local disturbance, with increased blood flow, and these conditions are known as *Active congestion*, *Active hyperæmia*, or *Determination*, and *Passive hyperæmia* or *Passive congestion*. As these conditions form an essential part in all inflammatory processes, it will be convenient to consider them here; though it must be distinctly understood that congestion is not necessarily an inflammatory condition. Any cause which retards the return of the blood through the veins—as, for instance, a ligature tied round a limb—may determine passive congestion, which is therefore a purely mechanical condition; whilst active congestion is a normal process, called into action by the needs of an increased supply of blood, for temporary purposes, in a thousand of the actions of daily life, such as the afflux of blood to the salivary glands during mastication, the turgescence of erectile organs, and even blushing, and therefore cannot be regarded as an inflammatory process or morbid condition, though it is frequently associated with disease and forms, as we shall hereafter see, an important element in all inflammatory processes.

ACTIVE CONGESTION OR DETERMINATION

Active congestion is an increased flow of blood *to* a part, with an increased rapidity of flow *through* the part, owing to a dilatation of the arteries and arterioles supplying it, from relaxation of their muscular coat. The blood in the part is therefore increased in quantity, flows with greater rapidity than natural, and is in consequence of a brighter colour than natural. If, for instance, a morsel of food is introduced into the mouth, there is at once an active congestion or determination of blood to the salivary glands; the arteries supplying the glands dilate, the blood rushes through them with increased velocity and in increased quantity, and thus, more blood being supplied to them, the functional activity of the glands is increased—there is a greater secretion of saliva for the salivation of the morsel of food. In this respect it is a perfectly normal condition and is produced by reflex action: the irritation of the sensory nerves of the mouth, induced by the food, causes immediate dilatation of the vessels supplying the salivary glands. The condition is often a very transitory one, the dilated vessels almost immediately recovering their normal calibre and the blood current slowing down to its normal rate of progress.

Causes.—When associated with disease, active congestion is caused by the application of some irritant, either mechanical or chemical. If, for instance, some irritant, as the prick of a needle, be applied to the web of a frog's foot, when viewed under the microscope, the small arterioles supplying the injured part will be seen to almost immediately dilate, an increased current of blood will be seen to at once flow to the part and rapidly traverse its vessels. Or, if a grain of dust becomes lodged in the eye, vessels will be seen shooting over parts which were previously perfectly white, denoting an increased afflux of blood to the part. The dilatation of the blood-vessels appears to be caused in one of two different ways: either as a reflex act due to irritation of the sensory nerves supplying the part, in which case it may be either a normal or a diseased action; or, secondly, by acting injuriously on the arteries and paralysing their muscular coats, in which case the condition is an abnormal one, and is, indeed, the first stage of inflammation.[1] The manner in which determination is set up as a reflex action is believed to be as follows: the muscular coats of the arteries are supplied by sympathetic nerves, and it is proved by experiment that when the sensory nerve supplying a given area is irritated, a condition of inhibition is set up, by reflex action, in the sympathetic vaso-motor fibres of the vessels supplying the area. As a result of this inhibition the tonic contraction of the muscular coat is lost and the vessels become dilated, with the natural result that an increased quantity of blood finds its way into them and there is a condition of active congestion. When, however, the irritant applied is sufficiently powerful to injuriously affect the coats of the vessels, the muscle cells of the middle coat become paralysed, and as a natural consequence the vessels become dilated and active congestion is set up as a morbid process, forming, as we shall hereafter see, the first phenomenon in the process of inflammation.

Symptoms.—The symptoms of active congestion are those which we should expect to find in a part in which there is an increased quantity of blood flowing with increased rapidity, and therefore parting with less oxygen, and consequently being of a brighter colour than natural. (1) In consequence of there being an increased quantity of blood in the part there is a certain but variable amount of swelling and a sensation of fulness. (2) Flowing with increased rapidity, the blood has time to part with but little of its oxygen to the tissues in its passage through the capillaries, so that that portion of it which is finding its way into the radicles of the veins, carrying the blood away from the congested area, is still to a considerable extent arterial, and this gives to the part, if it is on the surface of the body, a bright scarlet hue. (3) In consequence of the increased quantity of blood in the part there is an increase in its temperature, appreciable not only to the patient's sensations, but also to the hand of the surgeon.

So far it will be seen that the symptoms of active congestion are almost identically the same as those which were stated above as being the cardinal signs of inflammation, viz. modification of sensation—scarcely amounting, it is true, to pain—heat, redness, and swelling; but there is, in addition to these, another symptom—increased functional activity of the part—which is always found where the active congestion occurs as a physiological condition, in which there is an important difference from inflammation, where the functional activity is either perverted or diminished or, it may be, abolished.

Effects.—The effects of active congestion may be stated to be nil, as regards any evil consequences, so long as it is not long continued or frequently repeated. If this be so it may give rise to permanent dilatation of the capillaries and hypertrophy of the tissues comprised in the congested area.

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[1] See page 7.

PASSIVE CONGESTION

Passive congestion is a condition in which, as in determination, there is an increased quantity of blood in the part, but, in contradistinction to determination, it flows less rapidly than natural, and as a direct outcome of this becomes more deoxygenated, and therefore is of a darker colour than in the normal condition. It may occur quite independently of inflammation, or, on the other hand, it may be the direct outcome of it or act as a predisposing cause of it. The phenomena may be studied by tying a ligature fairly tightly round a part of the body—say a finger—sufficiently tightly to constrict the superficial veins and retard the flow of blood towards the heart through them, but not tightly enough to constrict the arteries and so prevent the ingress of blood to the part. In consequence of this, blood continues to flow into the constricted area, but being unable to find its way out through the compressed veins, it collects in the vessels, and thus there is increased blood in the part. In consequence of the impediment to the return of the blood through the veins, the circulation is retarded, and thus the flow is less rapid than natural; and from its prolonged stay in the capillaries the blood loses more and more of its oxygen and so becomes of a darker colour than natural. If we examine the vessels of the part we shall find that the arteries are of normal size or even diminished in calibre, while the capillaries and veins are enlarged and distended with black blood. If the constriction is allowed to remain long enough the circulation becomes entirely arrested, because the veins and capillaries become choked with blood and are unable to contain any more. When this occurs *stagnation* is said to take place.

Causes.—The most potent cause in the production of passive congestion is any obstruction to the return of the venous blood through the veins. An illustration of this has already been given in our experiment of tying a ligature tightly round a part of the body, but there are many others: the obstruction of a vein by a thrombus; the pressure of a tumour on a vein interfering with the circulation through it; the force of gravity from the long-continued dependent position of a part, especially where the valves in the vein are incompetent, may all give rise to passive congestion. But the arteries and capillaries may also be in fault in the production of this condition: for instance, increased resistance in the arteries may give rise to it. The arteries in old people may become so altered by degenerative changes that, though they are capable of allowing sufficient blood to pass through them to supply nutrition to the part, there is not sufficient pressure from behind to drive the blood onwards through the veins, and a condition of passive congestion is the result. In addition to these causes this condition may be set up by a diminution of the natural forces by which the circulation is carried on. This is especially the case when the propulsive power of the heart is weakened by old age or in exhausting diseases, so that it is no longer able to drive the blood through the capillaries, which therefore become gorged with blood, particularly in those parts which are most remote from the central organ of the circulation.

Symptoms.—The symptoms of passive congestion are those which one would naturally expect to find in a part in which there is an increased quantity of blood flowing with diminished rapidity. There is, first of all, swelling, due, at all events in the first instance, to the increased amount of blood in the part; there is a dull aching pain, caused by the pressure of the dilated blood-vessels on the terminal ends of the nerves; there is alteration in colour, varying from a dark-red to a purple, from the presence in the vessels of blood which has parted with a very considerable amount of its oxygen, and has become much deoxygenated, and therefore of a very dark colour: there is no elevation of temperature or sensation of increased heat in the part, but, on the contrary, in many instances, particularly where the cause of the passive congestion is persistent, there is a fall in the temperature below the normal standard. In passive congestion the functional activity of the part is lessened, as would naturally be expected from the diminished rapidity of the circulation.

Effects.—The effects of passive congestion may be either immediate or remote. The *immediate* effects are œdema and ecchymosis. They are both the mechanical results of the overloaded state of the vessels. As the vessels are full of blood flowing languidly through them or completely arrested in them, they endeavour to relieve themselves by either allowing the watery parts to transude through their walls into the peri-vascular spaces, and a condition of *œdema* is set up, or, if the vessels are diseased, they give way, and the blood is extravasated into the tissues of the part, producing *ecchymosis*. It would appear also to be probable, from experimental observations on the frog's foot, that the red corpuscles of the blood may pass through the walls of the blood-vessels, and produce ecchymosis in the peri-vascular spaces, without any rupture of the coats of the vessel.

The *remote* effects of passive congestion are pigmentation and induration. *Pigmentation* is the natural result of the extravasation of blood from the vessels into the tissues around. The red corpuscles are broken up and absorbed, leaving behind them some of the blood-pigment, which produces the purplish-brown colouration of the skin which is so frequently seen in the legs of patients who have been the subjects of long-continued passive congestion from varicose veins. *Induration* is the result of the growth of fibroid tissue principally around the vessels of a part which has long been the seat of passive congestion. This condition is also often met with in the legs of patients afflicted with varicose veins: the tissues are indurated and brawny, and sometimes increased in bulk, though the normal tissues are atrophied from the pressure of this new fibroid material upon them.

INFLAMMATION

So long as the various tissues of the body retain their vitality, they possess the property of undergoing nutritive and formative changes upon the application to them of a suitable stimulus. This fact led pathologists of former times to regard inflammation as a condition of *increased*, though perverted, activity of the process of nutrition. The converse of this, however, is the case. For, in 1858, Lord Lister arrived at the conclusion that there is a diminished functional activity in inflamed tissues, and this view has been adopted generally by pathologists. But although there is diminished functional activity in inflamed tissues, it must be distinctly borne in mind that inflammation is 'not a malignant energy working only for evil'; [1] it is not a disease even in itself, but is rather a curative process undertaken to defend the body from some injurious influence which has been brought to bear upon it.

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[1] Treves, *On Peritonitis*, p. 6.

Phenomena of Inflammation.—Our knowledge of the phenomena which take place in inflammation has been largely derived from experiment, by artificially producing inflammation in some transparent part of a living animal placed under the microscope. If the web of a frog's foot is examined by means of a high power, the blood will be seen to be passing in a stream from the small arteries, through the capillaries, into the veins (fig. 1). The blood will be noticed to flow in the capillaries in a continuous stream. The red corpuscles will be seen passing through the centre of the channel, in single file in the smallest vessels, with great regularity and considerable velocity. On either side of this central file, and between it and the wall of the vessel, there is a layer of liquor sanguinis, which moves more slowly than the corpuscles in the centre; this *inert* layer, as it is termed, is especially well marked in the smallest arteries and veins; here the red corpuscles will be found occupying the middle of the stream and moving with great rapidity; outside this, colourless corpuscles may be seen running much more slowly; and next the wall of the vessel is a transparent layer in which there is scarcely any motion; for, if occasionally a white corpuscle is seen to get into this layer, it will be noticed to move very slowly and irregularly. If from any cause the stream of blood through the vessel is slowed down sufficiently to enable the observer to distinguish individual corpuscles, it will be found that they show no tendency to adhere to each other or to the wall of the vessel, whereas if they are removed from the vessel they show a remarkable adhesiveness, sticking to each other or to any foreign body with which they may be brought in contact.

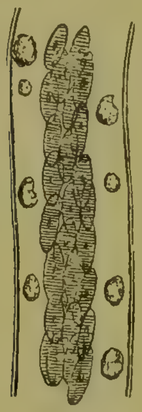

FIG. 1.—Normal circulation in a capillary from the web of a frog's foot: coloured corpuscles in centre of stream, leucocytes in inert layer.

Supposing that an irritant is now applied to the part, changes will be seen to occur which constitute the phenomena of inflammation.

First change.—The arterioles are seen to dilate, and the blood rushes through them with increased rapidity. The dilatation continues progressively, and is followed by a dilatation of the capillaries and veins, so that in a very short space of time the whole of the vessels of the part will be seen to be far above their normal size and the blood rushing through them with increased velocity. This is the condition of 'determination' or 'active congestion' above spoken of, and which, as was then shown, may be the first stage of inflammation. And, as Burdon Sanderson has pointed out, 'the employment of the term determination should be strictly limited to the primary acceleration of the blood stream in and about an injured part, and should not be so extended as to comprise the subsequent inflammatory congestion.'[1] It must be mentioned, however, that in some cases this dilatation is preceded by a momentary contraction of the arteries; that is to say, under the influence of certain irritants, but not of others, there will be noticed to be a momentary contraction or shrinking of the arteries before the dilatation takes place. This, as far as is known, appears to be a phenomenon of no great pathological significance, and depends apparently entirely upon the nature of the irritant employed to excite the inflammation.

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[1] *Lancet*, vol. i. 1876, p. 108.

The explanation of the cause of the dilatation of the vessels in an inflamed part has been shown by Lord Lister to be due to a temporary paralysis of their coats. He arrived at this conclusion from observations made upon the pigment cells in the web of a frog's foot. If the frog's foot is examined under the microscope it will be found to contain a large quantity of pigment cells, not only in the skin, but in the deeper tissues and especially along the blood-vessels. The protoplasm of these cells is always in active motion. At one time, if the frog is in a light room, so that there is abundant access of light to the frog's eye, the protoplasm containing the pigment granules retreats into the centre of the cells, where it becomes collected into a somewhat rounded mass and the frog becomes light in colour. If now the animal is removed into a dark room, or if the light is shut out from the frog's eye, the pigment-bearing protoplasm, leaving the centre of the cell, becomes diffused throughout various ramifications of the cells, which were previously not visible, and the whole tissue becomes permeated by pigment, and as a result the animal becomes dark. This phenomenon appears, therefore, to be a kind of reflex act excited by the access of light to the animal's eye.

Now if an irritant is applied to the part, no change takes place in the irritated area, though changes as usual take place in surrounding parts. Supposing, for instance, that the animal is in a light room, and therefore the pigment granules are aggregated in the centre of the cell when the irritant is applied, and that then the room is darkened or the light shut out from the frog's eyes, no changes whatever will take place in the pigment granules contained in the cells in the irritated area—they will still remain stationary in the middle of the cell; whereas in the cells outside the irritated area the pigment will become diffused throughout the tissue. The converse of this is also true: if, at the time of the application of the irritant, the pigment is diffused, from the light having been excluded from the animal's eyes, no collection into the centre of the cell will take place in the irritated area if light is admitted to the eyes, though it will do so throughout the rest of the foot. If the irritant is a temporary one, recovery gradually takes place; after a certain lapse of time the pigment begins to move, sluggishly at first, then with more vigour, and finally no difference can be observed in its movements from those which it had before the experiment was commenced. It is quite clear, therefore, that there is a temporary arrest of function or paralysis in these pigment cells as the direct result of the injury produced by the irritant; and if in these cells, it seems probable that the same temporary paralysis would affect all the cells of the part, including those of which the vessels are composed, and it seems reasonable to assume that the dilatation of the vessels is due to a temporary paralysis of them. But this explanation does not quite explain the whole of the phenomenon, for it is found that not only the vessels in the irritated area, and which alone could be affected by the irritant, are dilated, but also the vessels for some considerable area around—vessels which are quite beyond the action of the irritant, and which therefore cannot be in a condition of temporary paralysis. The dilatation in these vessels is believed to be due, as was mentioned in speaking of active congestion (see page 3), to a reflex act due to irritation of the sensory nerves of the part. The cause, therefore, of the first phenomenon of inflammation—viz. dilatation of the blood-vessels—may be regarded as twofold: first, a temporary paralysis of the blood-vessels acting especially at the focus of inflammation, and a condition of inhibition, set up as a reflex act in the vessels around.

Second change.—The acceleration of the flow of blood through the dilated vessels lasts as a rule only a very short time; it will shortly be noticed that the stream becomes slowed, and the corpuscles, which in the first instance were indistinguishable from each other on account of the rapidity of their movements, become now plainly distinguishable and can be differentiated from one another. The period at which this slowing down of the blood stream takes place is very variable and appears to depend in a great measure upon the nature of the irritant. If the irritant is very powerful, the acceleration of the blood stream is merely momentary and the retardation sets in at once; so much is this the case sometimes that it will be found, before the microscope can be brought to bear on the part, that the stream has become slowed down, and it will be seen that though the vessels are dilated the flow of blood is retarded, or it may be altogether arrested. On the other hand, if the irritant is slight—as, for example, if the mesentery of a frog is exposed to the air and examined under the microscope—retardation does not set in for some considerable time, and the blood continues to flow with increased rapidity during the whole of this period. As the stream becomes slowed and the individual corpuscles become distinguishable from each other, it will be noticed, if a single corpuscle is selected, that it shows a tendency to adhere to the wall of the vessel and to other corpuscles. This will be noticed at first especially in the white corpuscles, which appear to have a tendency to separate themselves from the axial blood stream, and whenever in their onward course they come in contact with the wall of the vessel they appear to stick for a moment to the lining membrane and then to flow on; when next they come in contact with the vessel they again adhere, and for a longer period; and this process is repeated with successively longer periods of adhesion, until at length they become finally arrested and remain permanently sticking to the wall of the vessel—unless, indeed, they pass out of the inflamed area, when they seem at once to lose their adhesiveness and flow along as in the normal circulation. In this way it will be found after a lapse of time that the lining membrane of the vessel may become coated with a layer of corpuscles adhering to it and giving it the appearance of an epithelial covering. This is especially noticeable in the small veins, where the force of the circulation is least. After a time, and while the white corpuscles are forming this sort of epithelial lining to the vessel, the axial stream also becomes slowed down, first in the veins and capillaries, then in the arteries. These changes can best be seen in the arterioles and venules of the inflamed area. In the capillaries, where the corpuscles can only pass in single file, no separation of the white corpuscles from the red occurs, but the retardation of the two takes place together. As the slowing down of the blood stream goes on, and the corpuscles become more adherent to each other and to the wall of the vessel, the vessel at last becomes choked with corpuscles which are unable to pass through it, and a complete arrest of the circulation takes place. This is known as *stasis*. This condition of stasis must not be confounded with *thrombosis*, another condition in which there is arrest in the circulation through a vessel. In the former, stasis, the fluid part of the blood, or plasma, still remains fluid between the closely packed corpuscles; whereas in the latter the plasma has undergone coagulation, and a solid clot has formed in the vessel. So that in the condition of stasis nothing is required for the complete recovery of the part but a cessation of the cause which induced the retardation. If this occurs the corpuscles no longer have a tendency to adhere, and it will be noticed that they first begin to oscillate, then to separate from each other and the wall of the vessel, and, slowly at first and then more rapidly, the blood stream is restored and the circulation resumes its normal character.

The retardation and stasis are thus seen to be clearly due to the tendency which the corpuscles acquire of adhering to each other and to the walls of the vessels, and it remains, therefore, now to inquire to what cause this adhesiveness is due It has been attributed respectively to (1) dilatation of the vessels, (2) changes in the corpuscles, and (3) changes in the vessels. It is quite clear that it cannot be due to the dilatation of the vessels, for when dilatation occurs from other causes no tendency in the corpuscles to adhere takes place. If, for instance, the sympathetic is divided in the neck, all the vessels —arteries, veins, and capillaries—become dilated, but the blood flows through them without showing the slightest tendency on the part of the corpuscles to adhere to the wall of the vessel. In like manner it cannot be due to changes in the corpuscles. It was formerly taught that it was, and it was believed by some pathologists that the corpuscles in an inflamed part underwent some change by which they became coated over with adhesive material, whereby they obtained this tendency to adhere together. But this undoubtedly cannot be so, for, as we have already seen, if a corpuscle passes out of the inflamed area it at once loses its adhesiveness, and flows onward in the circulation in a perfectly normal manner. Again, it is obvious that only one small portion of the blood can have been acted upon by the irritant, and that the blood in the area of stasis cannot be that portion which was thus acted upon, for it must have passed through the vessels of the part long before the occurrence of the stasis. And, finally, substances such as chloroform, which when applied to a part cause adhesiveness, interfere with coagulation when added to the blood. The tendency, therefore, which the corpuscles show in an inflamed area to adhere must be due to changes in the vessels. And it would appear to be due to the same cause which produced their primary dilatation—namely, an arrest in function or temporary paralysis. In the healthy condition of the vessels there is little or no tendency on the part of the corpuscles to adhere to each other or to the wall of the vessel, but when the corpuscles, either red or white, are removed from the body they show a great tendency to adhere; or if any foreign body is introduced into a vessel, or if the lining membrane of a vessel becomes altered by disease, the same tendency to adhesion to it of the corpuscles is at once seen. This would seem to show that there is a force at work in the vessels, the nature of which we are ignorant of, which counteracts the natural adhesiveness of the corpuscles, and that when inflammation is present, the walls of the vessels being in a state of suspended function, this power is diminished or lost.

Third change.—The third change in the inflammatory process consists in the passage through the walls of the vessels of the corpuscles and liquor sanguinis, which accumulate in the tissues outside the vessels.

As soon as retardation of the blood current sets in the exudation or emigration of the white corpuscles commences, followed after a time by the red. The emigration of the leucocytes is a very remarkable phenomenon, which was first actually observed by Cohnheim, though it had been previously demonstrated experimentally by other observers. This observation of Cohnheim's was of considerable importance in reference to the pathology of inflammation. For prior to this the views of Lord Lister, that in an acute inflammation there was a more or less complete suspension of the functional activity of the affected tissues, was not generally adopted. But the discovery by Cohnheim in 1867, by which the appearance of new cells in an inflamed area was fully accounted for without the necessity of supposing that there was any increased nutritive activity in the original tissue of the part, at once caused pathologists to accept these views. The migration can be best demonstrated by spreading out the mesentery of a frog on a glass plate, and no further irritation than exposure to the air should be applied. By adopting this plan the changes will take place slowly, and can be observed with accuracy. The dilatation, with increased rapidity of the flow, will first be noted, but some time will elapse before the vitality of the part is so much lowered as to induce the retardation of the blood. As soon as this commences, if a small vein, which is the most suitable for the observation, is selected, it will be noticed that there are first of all two currents—a rapid, axial one, in which the red corpuscles are contained, and a slower, marginal one, in which are the white corpuscles; these latter tend to stick to the wall of the vessel, and after a time the vessel becomes lined with a more or less complete layer of leucocytes, in the manner above described. If now an individual corpuscle is selected and watched, it will be gradually seen to pass through the coats of the vessel. First of all a little bud or projection will appear on the outer surface of the vessel, opposite the spot at which the corpuscle is adhering. This bud steadily increases in size, and as it does so the corpuscle inside the vessel correspondingly diminishes. After a lapse of time the bud outside the vessel will be as big as the remains of the corpuscle inside the vessel, and the leucocyte may then be compared to an hour-glass with two equal globes, one outside and one inside the vessel, connected by a narrowed portion *in* the wall of the vessel. The process still continues until gradually the whole of the corpuscle has disappeared from the vessel, and a body, somewhat pear-shaped and exactly resembling in size and structure the original corpuscle, is seen on the outside of the vessel, formed from the bud or projection which first appeared in this situation. This is at first still attached to the vessel wall by a sort of tongue or stalk, which finally gives way, and we have now a free body outside the vessel, identical in appearance and structure with the original leucocyte inside the vessel, and, like it, possessed of amœboid movements. When the process is completed the wall of the vessel shows no alteration at the part where the leucocytes passed through, but looks identically the same as it did before the process commenced (fig. 2).

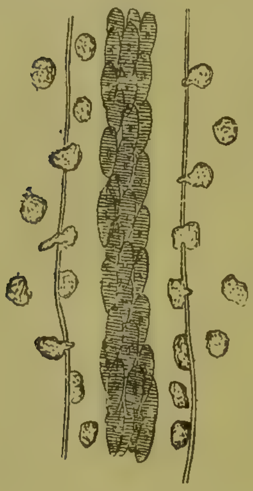
FIG. 2. — Emigration of leucocytes. Represented diagrammatically.

But not only do the white corpuscles migrate through the walls of the blood-vessels, but also to a certain extent the red corpuscles also pass out. These latter would appear to pass out mainly, if not altogether, through the capillary blood-vessels; whereas the emigration of the leucocytes seems to be the most active in the small veins, though they also pass out through the walls of the capillaries, and, according to some observers, through the walls of the smaller arteries also. In consequence of this migration the tissues of an inflamed part become crowded with leucocytes, and to a less, though varying, extent with red corpuscles, and by virtue of their amœboid movements the leucocytes wander away through the tissues, so that a very considerable area around the dilated vessels is seen to be infiltrated by them (fig. 3). The explanation of the migration is generally assumed to be that the white corpuscles pass out by their own amœboid movements, aided to a great extent by the pressure within the vessels; but that the coloured corpuscles are forced out by intra-vascular pressure alone, since not being possessed of any power of amœboid movements, they must be perfectly passive agents in the process. Formerly it was supposed that there were openings or 'stomata' in the walls of the capillaries, and that it was through these that the corpuscles passed out. Now it is believed that no such openings exist, but it would seem probable that they pass out between the cells of which the vessel wall is made up; the natural adhesion between the cells being lessened by the diminished functional activity resulting from the inflammation which has been set up.

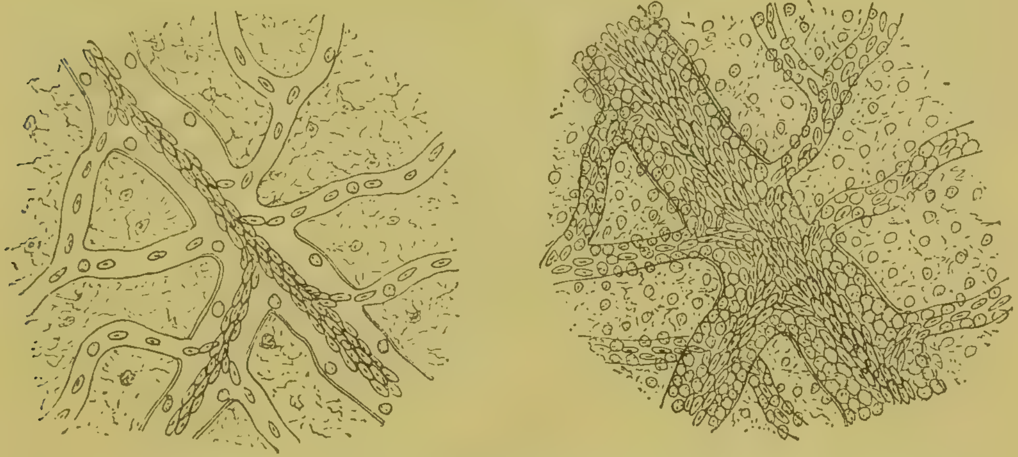

FIG. 3.—Normal and inflamed mesentery of a frog. In the inflamed mesentery the peri-vascular tissues are seen to be infiltrated with leucocytes and some few coloured corpuscles; the vessels are enlarged and choked with cells. Represented diagrammatically.

Another conceivable explanation has been given, and that is that the leucocyte, which is a mass of protoplasm, rebuilds the wall of the vessel which it is perforating (which is also protoplasm) as fast as it destroys it. It matters not which of these explanations is the correct one, for it is quite certain that a most important factor in the migration of the white corpuscles, as well as the red, is the intra-vascular pressure; for it has been found that ligature of the artery or arteries leading to the inflamed area very materially diminishes, and in some cases entirely arrests, the migration of the corpuscles.

Another theory as to the migration of the corpuscles and their subsequent movements in the tissues into which they have migrated requires to be mentioned. Some observers regard as the cause of the migration of the corpuscles, a peculiar influence which has received the name of 'chemiotaxis.' By this is meant the influence which various chemical substances, the products of the growth of micro-organisms in an inflamed part, have on the leucocytes. Some of these chemical products have the power of attracting the leucocytes, others of repelling them. The former of these is called 'positive chemiotaxis,' the latter 'negative chemiotaxis.' The theory which these observers hold is that all inflammations are the result of the presence of micro-organisms in the tissues, that these bodies during their growth produce certain chemical substances which, by virtue of their chemiotactic properties, draw out the corpuscles from the vessels, much in the same way as a magnet attracts a piece of steel. It cannot be denied that this may be one of the causes of migration, but it is quite clear that it cannot be the sole cause, for emigration occurs where the inflammation has been caused by mechanical means, in which there are, therefore, no micro-organisms, and where, therefore, there can be none of their chemical products.

While this emigration of the corpuscles has been going on, another and equally important change has been taking place : the fluid part of the blood, the plasma, has also been exuding through the walls of the vessels and collecting in the peri-vascular spaces around the emigrated corpuscles, so that the tissues of the inflamed area are not only infiltrated by corpuscles, but also permeated by the fluid elements of the blood. This exudation appears to be the result of a leaky condition of the walls of the vessels, which from their damaged state are unable to act any longer as filters, but allow the fluid constituents of the blood to pass through almost unchanged. It has been already noticed that in the condition of passive congestion the loaded vessels relieve themselves by filtering through their coats the serum of the blood, a fluid containing a small percentage of albumen and salt, and that they seem, therefore, to possess a discriminating power as to what shall pass through them—they act, in fact, as filters ; but when inflammation has been set up, and the functional activity of the vessel walls has been diminished by it, this discriminating power appears to be in a great measure destroyed, and the plasma of the blood passes through the walls of the vessels almost, if not quite, unchanged. This inflammatory exudation, therefore, which permeates the inflamed tissues, differs essentially from the passive exudation of congestion, and more especially in this important particular—that it is spontaneously coagulable, while the other is not.

This exuded material differs considerably in different forms of inflammation, both as regards quantity and quality. In a typical case of traumatic inflammation in a healthy subject, for example, it speedily coagulates and forms a clot, in which are entangled the migrated leucocytes and the red corpuscles which have passed out of the vessels. But in some cases the exudation is more watery, containing more serum and less fibrin factors, and under these circumstances it forms a less perfect clot, and is spoken of as a *sero-fibrinous* exudation ; whilst in other cases, no clotting takes place, or, at most, shreds of clotted material are seen floating in a fluid in which are contained the migrated leucocytes : this we term a *serous* exudation. Again, in other cases, there is a large admixture of red corpuscles, giving to the exudation an appearance of containing blood : this is known as a *hæmorrhagic* exudation. And, finally, in inflammations of mucous surfaces there is an abundant shedding of epithelium, which, mixing with the exudation, gives to it an appearance which is spoken of as *croupous* exudation.

In simple acute inflammation, the clot which is formed by the coagulation of the exudation is firm, and in the act of coagulation it entangles in its meshes the greater part of the leucocytes which have migrated from the vessels, as well as the red corpuscles ; it then contracts and squeezes out the serum, just as an ordinary clot does when blood has been drawn from the body, and thus becomes firmer and forms 'lymph,' the material which glues together the cut surfaces of wounds, and which may be seen on the surfaces of inflamed serous membranes.

Thus far, in describing the phenomena of inflammation, we have arrived at a stage in which the tissues of the inflamed area are infiltrated with a solid material which consists of leucocytes, with a varying proportion of red corpuscles, held together in the meshes of the coagulated fluid constituents of the blood. Around this area the lymph spaces are distended with the serum which has been squeezed out of the clot during its contraction, and is finding its way back into the circulation. It follows, therefore, that around the inflamed area there is always a greater or less amount of œdema where the tissues are infiltrated with this fluid.

Before we pass on to consider the further changes in the clot which has thus been formed, it is necessary to allude for a moment to the manner in which the coagulation takes place, as this has a bearing on the fate of some of the emigrated leucocytes. It is as follows : the fluid exudation is rich in fibrinogen, a proteid of the globulin class ; this is acted upon by a special unorganised ferment, called fibrin ferment, one of the products of the disintegration of some of the emigrated leucocytes, which have become disintegrated as a natural consequence of their having come in contact with foreign matter after they have left the vessels ; as a result of this the fibrinogen molecule is split into two parts : one part is a globulin, which remains in solution ; the other is the insoluble material fibrin, which appears as a meshwork of fine fibrils, entangling and enclosing within itself the blood corpuscles.

Fate of the Migrated Leucocytes.—Physiologists now describe several varieties of leucocytes as found in the human blood, but it will be sufficient for our purpose if we allude to the two principal varieties : one of these contains a considerable number of coarse granules, and is known as the *eosinophile* cell, from its staining with an acid aniline dye (eosin) ; the other is paler and less granular, and contains several nuclei united by fine threads ; these are the *neutrophile* cells, so called from their reaction with neutral aniline dyes. It is important to bear this fact in mind, for, as we have now to explain, there are two distinct and separate functions which the emigrated leucocytes have to perform, and it would seem probable that the one duty is performed by the one variety of leucocyte, the other duty by the other. The first function after migration which the leucocytes have to perform has just been alluded to : it is by their disintegration to set free the fibrin ferment and so induce coagulation of the exudation. This ferment does not exist in healthy blood contained in healthy blood-vessels, but as soon as the leucocytes leave the vessels and are thus brought into contact with foreign matter their disintegration is the natural result, and as one of the products of this disintegration fibrin ferment is formed. But all the leucocytes which migrate from the vessels do not disintegrate, and it would appear that it is some special variety which undergoes this process.

The other variety of leucocyte—that is to say, those which do not disintegrate—remain unchanged and permeate in every direction the damaged area ; this they do by their amœboid movements. But it is to be noted that they confine themselves to the damaged area, and do not stray beyond it. The explanation of this is twofold : they may confine themselves to the damaged area because there is less resistance here than elsewhere, in consequence of its being in a state of diminished activity, and this would seem to be the more probable explanation; or, secondly, their localisation in the inflamed area may be due to chemiotaxis—i.e. to the formation of some chemical products, the result of the growth of the micro-organisms which are the immediate cause of the inflammation and which attract the leucocytes. But it must be remembered that the same localisation of the leucocytes to the damaged area is to be observed in inflammation resulting from injuries, mechanical or chemical, where there are no micro-organisms. When the leucocytes have infiltrated the damaged area, they consume any portion of tissue which has been actually killed by the noxious agent that caused the inflammation, and which is no longer available for the purposes of the animal economy. This they do by throwing out pseudopodia around the dead matter and enclosing it in their own substance, and there consuming it. Thus they get rid of all effete material and pave the way for the process of repair. This would appear to be all their duty in a simple, non-infective inflammation, such as may arise from some local injury, and where there is an entire absence of any infecting agent in the shape of micro-organisms. But, as is well known, in a large number of acute inflammations, micro-organisms are present in the inflamed tissues, and are believed to be the cause of the inflammation.

According to Metchnikoff and those who follow his view, the leucocytes under these circumstances have another and a more important office to perform, and that is to seize and destroy the infecting micro-organisms themselves, and thus act as defenders of the body from the attacks of the invading microbes. This they are supposed to do in the same manner as that by which they destroy particles of dead matter: by surrounding the microbes by pseudopodia, taking them up into their substance, and destroying them by a process of intracellular digestion. In this way Metchnikoff would have us believe that there is a battle going on between the attacking micro-organisms and the defending leucocytes, in which the latter, in a healthy animal, are usually victorious, unless the microbes are extraordinary in number or virulence. This process is called *phagocytosis*, and the cells possessing the power of taking up into themselves and destroying foreign substances, whether bacteria or dead or effete tissue, are termed *phagocytes*. Other cells have this same power, but in inflammatory conditions it is probable that the leucocyte only acts in this manner. Attractive as the theory of phagocytosis is, it must be confessed that it is not sufficiently supported by evidence, and many facts have lately come to light which debar us from giving unqualified endorsement to it. In fact, by many it is entirely discredited. If it is true, it is quite clear that chemiotaxis has an important bearing upon it, for it is only in those cases where the products of the growth of the micro-organism have the power of attraction (positive chemiotaxis), and thus cause an abundant migration and infiltration of leucocytes, that it is possible that the cells can come into contact with the invading organisms and then destroy them, and so cut short the inflammation and cure the disease.

Until very recently the leucocytes which had emigrated from the vessels were supposed also to form new tissue. Before Cohnheim demonstrated the migration of the leucocytes it was universally taught that the cells which formed *granulation tissue*—a new tissue, which, as we shall see in the sequel, is a product of the inflammatory process—originated entirely from the proliferation of the connective tissue cells of the part; but after Cohnheim's views became generally accepted it was held that the cells of the granulation tissue were the leucocytes which had migrated from the vessels and undergone proliferation. Now, however, the views of those who have investigated the subject appear to have returned to the original idea that the cells of the granulation tissue are derived from the cells of the connective tissue of the part or their derivatives. It is necessary, therefore, to inquire into the fate of the white corpuscles after they have performed their office of scavengering the tissues and perhaps destroyed any invading microbes which may exist. The view that is pretty generally adopted is that they are destroyed by other phagocytes, derived from the cells of the original tissues of the part. These latter phagocytes are the cells to which allusion has just been made as the cells derived from the connective-tissue corpuscles or their derivatives by proliferation. They are considerably larger than the leucocytes, and are therefore sometimes termed *macro-phagocytes*, while the leucocytes are termed *micro-phagocytes*. Their office appears to be twofold: they act as scavengers and destroy and digest the leucocytes, which having performed their allotted duty must be regarded as foreign bodies; no doubt also they remove any fragments of tissue which have not been got rid of by the leucocytes; secondly, they form granulation tissue, which, as we shall see hereafter, is the element of repair in those cases of inflammation where there has been actual destruction of tissue.

Terminations and Results of Inflammation.—So far I have described the earlier stages of inflammation as they occur probably in every instance, and we now have to consider the ways in which this inflammation may terminate and the results to which it may give rise, and these will be seen to widely differ; the difference depending in a great measure upon the cause which gave rise to the process, and consequently to its intensity. If the cause is a slight one, of a very transient nature, *resolution* occurs—that is to say, the part returns to its normal condition. Let us take for example a very simple and momentary injury—the application of a crystal of common salt to the web of a frog's foot under the microscope. We note the various phenomena of inflammation—the dilatation of the blood-vessels, preceded, it may be, by a momentary contraction, and the acceleration of the blood stream; then we note the slowing down of the current, the white corpuscles separating themselves from the axial current and clinging to the walls of the vessels; and, finally, we may note the leucocytes passing through the walls of the vessels into the peri-vascular spaces. But now, the cause which excited the inflammation having been trivial and momentary, the process comes to a standstill, and a series of changes take place which result in the restoration of the part to its primitive condition. The corpuscles which have emigrated disappear—probably most of them re-enter the lymphatics and wander away; but it may be that others undergo a degenerative process and are absorbed by the lymphatics as débris. The exuded fluids become reabsorbed, passing into either the blood-vessels or, more usually, into the lymphatic vessels. The corpuscles within the vessels, which have become stationary, now begin to move again. At first they oscillate, then they break away from the wall of the vessel and from each other; they seem to lose their tendency to stick together, and flow along in the blood stream, which now begins to move onwards again, if complete stasis has taken place, and thus the circulation is restored to its normal condition. But supposing the irritant which has caused the inflammation has been a little more severe than this, so that it has actually damaged the tissues and probably killed minute portions, then the emigration of leucocytes which takes place is much greater, and these proceed to take up and digest these minute portions of dead tissue, without, however, altering or changing in any way the normal appearance of the part. When this has been done, the original cells of the part proliferate, and in their turn, acting as phagocytes, take up and destroy the migrated leucocytes, and then build up and repair the damaged tissue; so that in a very short time they seem to disappear, and the original normal tissue appears exactly as it was before the experiment was commenced.

So far we have described the process of inflammation and the restoration of the tissues to their normal condition without apparent change, and we have seen that this occurs only when the irritant which caused the inflammation was slight and temporary in its application. This condition of restoration is known as 'resolution.' We say that resolution has taken place, and we mean simply that there has been a return to a natural condition of health, leaving no trace in the tissues of the part to mark the process which has been going on. Should, however, the irritant which produced the inflammation be of a greater severity, so that the tissues to which it is applied are extensively damaged or, it may be, small portions killed outright, or should the irritant, instead of being momentarily applied, be more persistent, especially in those cases where the tissues are invaded by certain micro-organisms, then the migration of leucocytes is very much more abundant: instead of a few of these bodies finding their way out of the vessels, they pass out in countless numbers, and become heaped up in the inflamed tissue until the part seems incapable of holding any more. They then commence their work, and under their influence the original tissues degenerate and disintegrate, so that whereas there was, in the first instance, the original tissue of the part infiltrated with round cells—leucocytes—now there is nothing but these round cells, all trace of the original tissue having disappeared. Thus the connective tissues become swollen and softened, and finally disappear; bone, cartilage, adipose tissue, muscular fibre—all in the same manner disappear under the action of these migrated leucocytes (phagocytes). No matter what the tissue is or how complex the structure of the organ in which the inflammation occurs, provided the disease has lasted long enough, the special structure or tissue of that organ disappears, and its place is taken in the first instance by a number of small round cells, which are the emigrated leucocytes. The process can be best studied in a piece of muscular tissue, where it will be seen that these emigrating cells penetrate through the sarcolemma into the muscular fibres, which speedily lose their striation and then become granular; gradually all trace of the muscular tissue disappears, and at last nothing remains but a mass of round cells. So that in these cases where the irritant has been more severe or applied for a long time there is an actual loss of the original tissue of the part, and the appearance in its place of a number of round cells. But, following the most recent observations on this subject, it would appear that these small round cells do not remain, nor do they undergo any further change; their life-work is completed, and now they must be regarded as foreign bodies, and means taken for their removal. The cells of the tissues in the neighbourhood which have not been killed or so severely damaged as to require removal, as soon as they have recovered from the slight damage which has been done to them by the irritant, begin to proliferate, and soon the mass of small round cells is infiltrated by larger motile cells, formed by this proliferation of the original cells of the part, which also possess the properties of phagocytosis. These, in their turn, eat up and destroy the small round cells and occupy the space which was formed by the removal of the damaged tissues by the emigrated leucocytes. In this mass of cells vessels are formed, probably for the most part by the budding out from the endothelial cells of adjacent capillaries: these buds become joined with others arising from capillaries in the neighbourhood and, becoming hollowed out, form new vessels. In this way a new tissue has been formed, which is known under the name of *granulation tissue*. This name is given to it because its structure is of the same elementary character as that of the granulations on the surface of a healing ulcer. It consists simply of cells adhering to each other—i.e. embedded in an apparently homogeneous matrix amongst which ramify innumerable thin-walled capillaries. The cells of the tissue are for the most part round, especially if an examination be made at a very early stage, but they have, under certain conditions, a tendency to become spindle-shaped and elongated, so that it is seldom the case in examining granulation tissue that nothing but round cells are found: there are often seen also spindle-shaped cells, fibre cells, and immature fibrous tissue.

The **granulation tissue,** thus formed from the fixed connective tissue cells of the part, may undergo one of two changes: it may either undergo a developmental change or a degenerative change. Which of these changes it undergoes would appear to depend mainly upon the amount of nutritive supply afforded to it, for in the same mass of tissue we may see the two changes going on contemporaneously. In the centre of the mass, at the point furthest removed from the source of nutrition, degenerative changes will be seen taking place; whilst at the periphery, where more nutrition can be supplied by adjacent blood-vessels, developmental changes will be found to be going on.

1. The **developmental** change is sometimes termed *retrogression*, because it consists in the formation of a new material, of a less complex nature than the original tissue which it replaces. The character of the new material varies to a certain extent, but it belongs to the connective tissue type and assumes the characters of the connective tissue in which it is formed. Thus if the inflammation has been in bone, of which a portion has been removed by the inflammatory process and its place occupied by granulation tissue, this tissue eventually ultimately undergoes a development into bone. So, again, if the tissue inflamed has been fibrous tissue, the new material formed from the granulation tissue becomes dense fibrous tissue. But it must be borne in mind that where the more complex tissues, such as muscle, cartilage, skin, are destroyed, they are never restored, but the granulation tissue which is formed in these cases becomes converted into new fibrous tissue. This new material which arises from the developmental process which goes on in granulation tissue is known as 'scar' tissue: it will be considered more in detail in connection with the subject of the union of wounds, where the gradual developmental processes which it goes through, and its structure, can most conveniently be studied. It will be sufficient in this place to say that the process in all probability consists in the elongation of the round cells of which the granulation tissue in the first place consists. The cells first become spindle-shaped; then they become more elongated and assume the form of fibre cells, and eventually form the fibres of fibrous tissue, which become bound together by an interstitial homogeneous cement substance. Thus a new fibrous tissue is formed, which may undergo further changes according to the nature of the connective tissue in which it is formed. Thus, in

the instance cited above where the inflammation was in bone, earthy salts become deposited in the new fibrous tissue, and it gradually undergoes a transformation into true bony tissue. A further change must be noted as occurring in scar tissue after its formation, and that is its contraction. This is especially noticeable in the scar tissue which remains fibrous. This undergoes, for a considerable time after its formation, a progressive contraction, in consequence of which the vessels contained in it become atrophied and obliterated, and as a consequence the scar tissue becomes less vascular and paler than surrounding parts ; it also becomes hard and dense, often feeling to the touch like a mass of cartilage. During its contraction it draws towards itself surrounding parts with which it is in contact, and thus often produces great deformity. This is well exemplified in burns, where sometimes the most distressing and hideous deformities are produced as the result of the contraction of scar tissue.

2. The **degenerative** change in granulation tissue occurs where the inflammation is persistent, owing to the presence in the inflamed area of pyogenic organisms, without which this change will not occur. This degenerative change, when it takes place in the substance of tissues which surround the inflammatory products on all sides, so that they are enclosed and cannot escape, is known as *suppuration* ; when, on the other hand, it occurs on a free surface, so that the products of the change can at once escape, it is known as *ulceration* ; the two conditions being pathologically identical. The process consists essentially in the death of the cells of the granulation tissue and its liquefaction. The process begins in the centre of the mass at the point furthest removed from nutrition : liquefaction takes place, and a cavity is formed containing a fluid in which are innumerable corpuscles, and this fluid is called *pus*. It may be, and probably is, the fact that this degenerative process takes place in the inflammatory exudation before true granulation tissue is formed—that is to say, before the emigrated leucocytes have been destroyed and removed by the proliferated fixed connective tissue cells of the part, but after the leucocytes have destroyed and removed the damaged tissues ; so that it is these leucocytes and not the connective tissue cells, which degenerate and die, and which form the pus cells. This process, commencing in the centre of the mass of granulation tissue or inflammatory exudation gradually extends until the whole mass is liquefied and converted into pus ; but as it does so active inflammatory processes proceed in the adjacent structures, and a fresh layer of granulation tissue is formed around the liquefying centre, whether it be in the depth of the tissues or on a free surface, which in its turn liquefies and is converted into pus, and so the abscess or ulcer extends and increases, and thus a progressive destruction of tissue takes place. These processes of suppuration and ulceration will be considered more in detail hereafter.

Finally, as a result of inflammation, must be mentioned *gangrene*, or death of the part *en masse* in consequence of the violence of the inflammation and the occurrence of stasis over a very wide area, so that a portion of that area cannot recover itself, and death of the part is the natural consequence. When, however, we come to speak of gangrene, we shall find that only a very few cases are caused in this way, and that there are many other causes which produce it. Between, however, this condition of gangrene and suppuration we shall find that no sharp line of demarcation can be drawn, but that the one condition merges into the other, in accordance with the severity of the irritant and the power of the tissues to resist its injurious effect. Supposing, for instance, that the irritant which has produced the inflammation is so severe that some of the tissues undergo disintegration before they can be replaced by leucocytes, we shall have, when the process of liquefaction takes place, a fluid in which are pus cells, the dead leucocytes, and also shreds of broken-down tissue, which have not been taken up by the leucocytes before they died, and therefore a combination of the suppurative and gangrenous processes.

To sum up then the results of inflammation: we have (1) **resolution**; that is, the return of the part to its original condition without any alteration or destruction of tissue. (2) **Retrogression**; or the formation of a new structure of a less complex nature than the original tissue. (3) **Suppuration**, or the formation of pus, a degenerative process, which occurs where the inflammation is persistent. (4) **Ulceration**; a process analogous to suppuration, but occurring on a free surface, so that the pus cells find a ready escape. (5) **Gangrene**, or death of the inflamed part *en masse*, generally the result of the tissues being invaded by micro-organisms, which generate chemical products that kill the tissues; but also sometimes caused by the intensity of the inflammation, and the arrest of the circulation from the stasis and pressure of the migrated organisms.

Causes of Inflammation.—The causes of inflammation, like those of most other morbid conditions, may be considered under the two heads of *exciting* causes and *predisposing* causes.

I. **Exciting Causes.**—There is no doubt that the most important and the most common of all external injurious influences which cause inflammation is the invasion of the tissues by pathogenic micro-organisms, and there are some pathologists who hold that this is the only cause of inflammation, and that no injury alone is competent to produce inflammation without the intervention of these micro-organisms. These pathologists teach that repair and inflammation are not only 'not identical, but that they are incompatible. That repair is a *constructive* physiological process, and resembles closely that of development and growth. But that inflammation is a *destructive* pathological process, brought about entirely by micro-organisms introduced from without, and that if it attacks a wound in the process of repair, it at first checks this repair, and later on brings about disorganising changes; and that when a part repairs after it has been the seat of inflammation, it does so only when the inflammatory process has been arrested.'[1] The whole subject hinges upon the one point of what we mean by inflammation. If we adopt the definition of Burdon Sanderson, that inflammation is 'the response of living tissues to injury,' the whole argument falls to the ground, and we must admit that any and every injury is followed by inflammation. But irrespective of this, it seems to me that abundant evidence can be deduced to prove that inflammation may be induced without the concurrence of micro-organisms; an inflammation, it is true, which differs from that excited by these bodies, since it neither tends to spread to contiguous parts beyond the area of injury, nor does it infect distant parts by the circulation. It will therefore be convenient to consider the exciting causes of inflammation, which are usually spoken of as irritants, under the three following heads: (1) Direct injury; (2) The chemical products of putrefaction; (3) Infective micro-organisms.

1. **Direct Injury.**—Under the head of direct injury must be included many different causes, some mechanical, some chemical, and some

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[1] *Hunterian Oration*, Bryant, 1893.

physical. Local injuries such as produce contusions, wounds, fractures, or dislocations; a condition of unrest, from tension, friction, the presence of foreign bodies, or even, in some cases, excessive use of a part, may all be regarded as mechanical irritants productive of inflammation. Then, again, the application of strong acids or alkalies, and certain salts, as chloride of zinc; or some animal and vegetable products, as cantharides, croton oil and mustard, will cause inflammation, and may be regarded as chemical irritants. Finally, excessive heat or cold, and electrical stimulation, when it gives rise to decomposition of the tissues, are physical irritants that may give rise to inflammation, without the presence of micro-organisms, though it must be admitted that these injuries are much more likely to be followed by inflammation; and that this inflammation is of a much more serious character when micro-organisms are present in the part.

2. **The Chemical Products of Putrefaction.**—The chemical products of putrefaction appear to play an important part in the production of inflammation, especially in the spreading infective inflammation which sometimes attacks wounds.

Putrefaction is a fermentative process, and consists in the rapid and intense decomposition of nitrogenous, and especially albuminoid, substances under the influence of certain bacteria. During the process, as a product of the growth of these bacteria, a chemical substance is formed, called *ptomaine*, which soaks into the tissues, and, acting as an irritant, excites inflammation, and not only causes the inflammation, but by its continuance in the part causes a prolongation of the inflammatory process, so that it assumes one of the severer forms, such as suppuration, to which we have alluded. The bacteria which excite ordinary putrefaction appear to be capable of acting only on dead matter. When introduced into the blood stream of a living animal, they disappear without producing any ill effect, unless they are injected in such quantities that they cannot rapidly be absorbed. The essentials, therefore, of putrefaction are dead animal matter and the presence of a ferment, and to these must be added the presence of oxygen and water, and the maintenance of a certain temperature; but of course these conditions are always present in the living body. The dead animal matter which usually undergoes this putrefactive change, and which, therefore, is the primary cause of the inflammation, is the serum of the blood; the serum which is squeezed out of the clot after its coagulation, and during its subsequent contraction. Take, for example, an ordinary wound, after its infliction, the first thing that happens is the arrest of the hæmorrhage; if the wound is only of a certain size, and no considerable vessel has been injured, this arrest takes place as a perfectly natural process. It is brought about by the formation of clots in the mouths of the cut vessels, for reasons which will be mentioned in speaking about injuries to blood-vessels. These clots then contract, and as they do so they squeeze out from themselves the serum contained within them: if this serum escapes from the wound no evil results; but if, on the other hand, it is retained, and there chance to be present in the wound, as very probably there may be, some of the bacteria of putrefaction, the fermentative process is set up, ptomaines are formed, and a severe form of inflammation is the result. For the serum which has been expressed from the clot is dead animal matter. So also in many wounds, such as compound fractures and wounds opening the cavities of the body, it is impossible always to get rid of all the blood which has been extravasated ; some remains in the wound, and either coagulates and, exuding its serum, affords a dead material capable of undergoing putrefaction, or may itself undergo putrefaction, though it is less easily decomposable than the serum, since it is composed to a large extent of living cells.

The ferment of putrefaction consists of certain vegetable organisms belonging to the lowest order of fungi, and, as we have seen, they are capable of developing only in dead matter; they are therefore known as *septic organisms* or *carrion fungi* (saprophytes), in contradistinction to certain other micro-organisms which have the power of living and growing in the living tissues and which are known as *infective* or *pathogenic micro-organisms.*

3. **Infective Micro-organisms.**—The infective micro-organisms play an important part in the causation of inflammation. As they also play an important rôle in the production of many diseases which will hereafter have to be described, it will be convenient in this place to consider very briefly and generally the subject of Surgical Bacteriology, so far as it is necessary to explain what will have to be stated in the sequel.

The term **Bacteria** is generally employed to designate the whole group of micro-organisms which have a definite relation to disease. The term is an unfortunate one, since its meaning is a staff or rod, and amongst these micro-organisms are a number of rounded bodies ; but it is sufficiently well understood and recognised as including the whole group.

For purposes of classification it is sufficient to divide bacteria into (1) *micrococci*, spherical bodies ; (2) *bacilli*, rod-shaped bodies ; and (3) *spirilla*, spiral or screw-shaped organisms.

The **Micrococci** are rounded or slightly oval bodies, varying from $\frac{1}{25000}$ to $\frac{1}{10000}$ of an inch in diameter. They are non-motile and multiply by fission. In consequence of their different modes of division several sub-varieties are recognised. In some instances the fission is complete and the divided bodies become entirely separated from each other : then the micrococci occur singly, and, when collected into colonies, are termed *zooglœa.* Sometimes the fission is not quite complete, but the two halves remain united to each other by a slight bond of union, or the division may be complete, but the new organisms remain in contact ; then the micrococci are grouped in pairs, and form what are called *diplococci.* The diplococci may undergo further division, each new organism again dividing into two, and this may be repeated many times, and if the organisms still remain attached to each other, we shall have a long chain of rounded bodies ; these are called *streptococci.* When the division of the original micrococcus does not take place in the same plane, but the new organisms remain attached to each other, we have irregular mulberry-shaped masses, which are termed *staphylococci.*

The **Bacilli** are rod-shaped organisms, varying from the $\frac{1}{20000}$ to the $\frac{1}{1250}$ of an inch in length, and are always more than twice their breadth in length. They are for the most part non-motile, but some are provided with *flagella* or *cilia*, formed as a secondary modification of the external membrane, and are then motile. They multiply by fission and also by spores under certain conditions. These spores appear as bright spots which grow at the expense of the protoplasm ; they are possessed of considerable vitality, and resist to a great extent the effects of heat and cold and many antiseptic substances. Sometimes the bacilli become very much lengthened, forming slender thread-like bodies ; to these the term *leptothrix* is given.

The **Spirilla** are spiral, screw-shaped organisms, consisting of long chains twisted like a corkscrew and possessed of active movements.

These micro-organisms consist of a delicate protoplasm or vegetable albumen contained in a dense, resisting membrane containing cellulose. In some, colouring matter is found in this membrane and also, though much less frequently, in the protoplasm itself. This may give rise to colouration, which is visible to the naked eye. Under ordinary circumstances, however, the protoplasm is colourless, or faintly yellow, and either homogeneous or granular in appearance. In order that they may live and grow, the micro-organisms require suitable food. Some of them grow and flourish in proteid or albuminous substances; others again appear to require carbo-hydrates, and all require a free supply of water, without which they cannot grow. Some grow best with a supply of free oxygen, and these are termed 'aërobic'; whilst others require that free oxygen—that is to say, air—should be rigidly excluded. What small amount of oxygen they require, they obtain from the organic compounds in which they grow. These are termed 'anaërobic.' Some, as we have seen, are capable of living and growing on dead animal matter; they have therefore received the name of *saprophytic fungi*: others attack living tissues and can grow only on or in the animal body, like true parasites; these are therefore termed *parasitic fungi*. Some of these have never been cultivated outside the body, whilst others, though usually living outside the body, are capable of growing in it and setting up certain definite pathogenic conditions. For the most part micro-organisms develop and grow most readily at about the temperature of 95° F.; but they may still continue to grow with a diminution of their functional activity within certain limits of temperature. It may be stated generally that bacteria cease to grow at a higher temperature than 105° F. or a lower temperature than 80° F. Heat is the surest and quickest method of killing bacteria; some spores are killed in a few minutes in water at the temperature of 212° F., and moist heat kills more rapidly than dry heat. Direct sunlight also retards their growth and may kill them.

The most important point in connection with the growth of these micro-organisms is the power they possess of producing certain chemical compounds, which are termed 'toxines' and which are really the noxious elements. We have already seen that this is the case with regard to putrefaction, where it was stated that it was not the bacteria, the cause of the fermentation which set up the inflammation, but the chemical products (ptomaines) resulting from the growth of the organisms. It is in consequence of this fact that, though the lesion, the original source of the condition, is strictly localised, and therefore the region permeated by the micro-organism may be also strictly localised, still the most profound constitutional effects may be produced by the formation of these toxines, which, being exceedingly soluble, are carried to all parts of the body in the blood.

Bacteria are very widely distributed. They are present in the air, but not in the quantities which it was formerly supposed; for it is only those which can survive the absence of moisture and are adherent to particles of dust which can be carried in this way. No doubt in those places where bacteria are being generated in vast quantities a large number may be found circulating in the air. Sims Woodhead has shown that the tubercle bacillus was present in large numbers in the air of a room in which a considerable number of tuberculous animals were confined. And no doubt in a hospital ward containing a number of patients with wounds in a state of suppuration or decomposition we should expect to find a considerable number of bacteria in the air. Water would appear to contain more micro-organisms than air, no doubt on account of the fact that, as we have seen, water is necessary for the life of all bacteria. But for the most part the bacteria found in water are non-pathogenic, and, moreover, can be entirely destroyed by boiling the water for a few minutes.

There can be no question that the favourite habitat of bacteria is the free surface of the body and some of the cavities connected with it, as the mouth, nose, intestine, and vagina. Here they are provided with the two great essentials which, as we have seen, are necessary for their growth, namely, moisture and a certain temperature.

The surface of the skin is always to a certain extent moist, and micro-organisms brought into contact with it find a favourable habitat, and, accumulating, may speedily be distributed over its surface. Many distinct species have been found on the surface of the body and in some of its cavities ; and though most of these are harmless, others are potent for evil, should they effect an entrance through any abrasion of the cutaneous or mucous surfaces.

The general characters of the whole of this group of micro-organisms are closely allied to the lower forms of vegetable life, but in addition to these there are some animal parasites which also cause inflammation, such as the itch insect, the trichina spiralis, &c., which will be described hereafter. The most important, however, are the vegetable parasitic fungi ; these grow into the surrounding tissues, exciting inflammation as they spread ; they enter the circulation by the blood stream or lymph, and cause a true infection both locally and generally. The inflammation they excite is termed infective.

II. **Predisposing causes of inflammation.**—The consideration of the predisposing causes of inflammation need not occupy us long, for they may be summed up in a very few words. Anything which depresses the vital powers may be regarded as a predisposing cause of inflammation ; for example, *hereditary tendencies*, as gout, syphilis, scrofula ; *bad habits*, as excess in eating or drinking ; *faulty hygienic and dietetic surroundings*, as bad air, bad food, starvation ; *weakened nerve power*, as when the nervous supply to a part is cut off ; *certain states of the blood*, as in albuminuria, disease of the liver, diabetes, and anæmia.

Symptoms of acute inflammation.—The symptoms of acute inflammation are both local and general.

1. **Local symptoms.**—The four local signs or symptoms of acute inflammation as originally laid down by Celsus are 'pain, heat, redness, and swelling,' and to these it is generally the custom to add a fifth, viz. modification of function. It must be borne in mind that it is the sum of these symptoms which indicates the inflammatory process, and not any one single symptom, for occurring singly they may be due to other causes. Of the four cardinal signs, probably the increased heat of the part is the most characteristic sign, though occurring alone it is not necessarily indicative of inflammation. When, however, the four symptoms are all present in a part they always indicate inflammation.

The *pain* is due to the pressure exercised on the terminal branches of nerves by the dilated blood-vessels, and is always therefore greater when the inflamed part is in a dependent position, because under these circumstances the vessels are more distended with blood. It will often be found, therefore, that the pain of inflammation may to a very great extent be relieved by attention to position. Another characteristic of inflammatory pain is that it is increased on pressure ; this is only what one would expect, for in all probability the nerves themselves are the seat of inflammatory change in an inflamed part, and hence any external pressure by pressing on these nerves occasions increased pain. The increase of pain on pressure may become an important sign in diagnosing inflammatory from other kinds of pain, as, for instance, neuralgia, where the pain is often relieved by pressure. The intensity of the pain in inflammation varies very considerably, and the variation depends more on the structure affected than on the amount of inflammation, and would appear to depend in a great measure on the amount of tension to which the parts are subjected ; thus in dense, resisting structures, such as fibrous tissue, the pain is very great, whereas in loose, connective tissue, which is extensible and easily yields, the pain is often comparatively slight.

The character of the pain seems to vary, within certain limits, according to the tissue or organ inflamed. Thus the pain which is characteristic of inflammation of serous membranes is of an acute, lancinating character, while that of mucous membranes is of a burning character ; the pain produced by inflammation of bone is of a gnawing or aching character, and is worse at night ; the pain of an inflamed testicle or kidney is described as sickening ; and, finally, the pain when suppuration is occurring is of a throbbing character, and this often affords an important diagnostic sign to the surgeon.

The *heat* in an acutely inflamed part is always greater, so as to give a sensation of increased heat to the hand placed upon it. This increased temperature is no doubt mainly, if not entirely, due to the larger quantity of blood and not to any appreciable extent to the generation of heat in the part itself, as was formerly thought to be the case. It is possible, however, that owing to the active chemical changes which are going on there may be a very slight development of heat in the part, but the matter is not one of any great practical importance.

The *redness* in acute inflammation is due to the dilatation of the blood-vessels and the accumulation of red corpuscles in them. At the marginal part of the inflamed area there is a bright red colour, gradually shading off into the normal condition of the skin ; the redness here disappears on pressure, because the inflammation is in the first stage—namely, that of simple dilatation—and therefore the pressure of the finger drives the corpuscles from the vessels subjected to pressure into neighbouring capillaries. Towards the centre of the inflamed area the redness is of a darker hue, in consequence of the retarded flow, and the fact that in consequence of this retardation there has been time for the red corpuscles to part with their oxygen, and the oxyhæmoglobin to be deoxygenated. The redness here persists on pressure, because all the vessels being choked the corpuscles cannot be expelled from any one vessel by the pressure of the finger. If the inflammation has existed for any little while, there is also a certain amount of pigmentation of the tissues, because some of the red corpuscles have passed through the walls of the blood-vessels, into the peri-vascular spaces, and have there disintegrated and left their pigment behind. Hence it follows in these cases that when the inflammation subsides and the vessels recover their tone, a certain amount of colouration remains, owing to this pigmentation of the tissues.

The *swelling* in acute inflammation is due to the increased efflux of blood in the first instance, and secondly to the exudation which has taken place.

It varies very much with the tissue or organ inflamed; thus in loose and lax parts, like the cellular tissue of the eyelids or scrotum, it is very great; while in hard and dense parts, like bone, it is very slight. After the inflammation has existed some short time, the swelling towards its centre is hard and brawny, because here inflammatory exudation has taken place, with subsequent coagulation of the effused products; whilst at the margin the swelling is soft and pits on pressure, because here the exudation is probably serous only, or at all events no coagulation has, as yet, occurred.

In addition to these four cardinal signs of inflammation, there is, as we have stated above, some *modification in the functional activity of the part*, which is decreased or perverted. This modification is always of a degenerated or perverted type. Thus the use of the part is interfered with: the inflamed eye cannot bear the light; an inflamed joint cannot bear movement or a muscle contraction, and the bladder cannot bear the presence of urine; or, again, the secretion of secreting glands and surfaces is modified; it is true they may pour out an abundant secretion, but it is not healthy and normal in character, rather a vicious fluid, which denotes a perverted activity in the function of the part.

2. **General symptoms.**—In acute inflammation there is always more or less disturbance in the general condition, varying according to the intensity or cause of the inflammation. This constitutional disturbance assumes the form of fever, and the essential sign of it is elevation of the temperature.

If the inflammation is simple in its character and has been caused by some mechanical violence, the rise in the temperature is not very great, hardly ever above 102° F., and this may be almost the only symptom of fever present, or, conjoined with it, there may be other febrile symptoms; a general feeling of malaise and discomfort, the patient feeling alternately hot and cold and sometimes shivering; the pulse is quickened, the skin hot and dry, the tongue furred, the urine scanty and high coloured, and the bowels constipated; if they act, the motions are offensive; the patient is restless and complains of thirst and want of appetite, and headache is often present. The fever, however, speedily declines, the temperature becomes lower and usually normal in the course of a few days, the restlessness and discomfort disappear, the patient regains his appetite and expresses himself as feeling more comfortable. But in other cases the fever does not decline. Before, however, we consider this, it will be desirable to consider to what the increase of temperature is due. It is clear that it cannot be due to the introduction of septic organisms or their products into the blood, for it occurs in cases where there is no putrefaction, and where the inflammation runs a perfectly simple course and terminates in resolution or the retrogressive form of the disease. It has been shown by Edelberg, Köhler, and others that the introduction into the blood stream of 'fibrin ferment' produced symptoms varying in intensity according to the amount of the ferment injected. When introduced in small quantities it caused elevation of temperature and other symptoms resembling a mild form of septicæmia, which subsided after a brief duration, and the animal recovered: when, however, it was injected in larger quantities it caused coagulation of the blood in the right ventricle and the death of the animal. Now it has already been mentioned that in inflammation a large number of the emigrated leucocytes undergo disintegration and during this process set free a considerable amount of fibrin ferment. It seems, therefore, to be a fair inference that the primary traumatic fever following injuries and operations is due to the circulation in the blood of the ferment set free by the disintegration of the emigrated leucocytes. There is, however, another theory as to the causation of this febrile condition. It is known to physiologists that there is a heat-regulating centre situated in the medulla which presides over and controls the heat of the body, maintaining it when in health at a uniform temperature. It is believed by some that in inflammation this centre is thrown out of gear, either as the result of the interference with its nutrition owing to the vitiated blood from the inflamed area flowing through it, or as a reflex act, brought about by the tension on the peripheral terminations of the sensory nerves of the inflamed part.

The fever which follows an injury or operation may not, as we have said, subside in the course of a few days; this is due to the presence of some source of irritation; it may be the presence of a foreign body, or tension from too tight sutures, or some other condition of unrest, and these cases generally terminate in suppuration; or the fever may subside, and the temperature become normal, or almost normal, and may then again rise. This is due to the absorption into the blood of the products of decomposition. These are powerful pyrogenic substances, and can easily be absorbed from raw surfaces, less easily after granulations are formed, as these structures appear to act as barriers to absorption. Thus after a wound, if drainage is not provided for, dead animal matter—e.g. serum—may be retained in the wound and undergo putrefaction; the ptomaines, the products of this fermentative process, are rapidly absorbed from the raw surface, and, carried in the circulation, act as pyrogenic agents and maintain the high temperature. At the end of a week or ten days the temperature will, however, fall, though perhaps not quite to normal; this is due to granulations having formed, which, acting as barriers, prevent the further absorption of the chemical products of the decomposition. Again, the fever may continue and the temperature remain high where there is no decomposition going on, and where there can be, therefore, no absorption of its products into the blood. This is due to the absorption of the chemical products of the growth of infective micro-organisms into the blood. These organisms multiply in the living body, and therefore the effects they produce are not proportional to the amount of the poison which has been inoculated or introduced into the system.

Acute inflammatory or symptomatic fever varies not only in its intensity but also in its form, according to the condition of the patient and the nature of the pyrogenic substance which excites it. Two distinct varieties are usually described, the *sthenic* and the *asthenic*, but between these two extremes there will be found to be an infinite variety of gradations.

(1) The *sthenic* form occurs in the hale and strong. It is characterised by a full, bounding, incompressible pulse, generally accelerated some thirty or forty beats in a minute; a hot, moist skin, with a rapidly mounting temperature to 102° F. or 103° F.; the tongue is furred, white, and moist; the respirations are increased in frequency; the face is suffused; there is thirst, loss of appetite, and the secretions are diminished; there are often nervous complications, languor, headache, and sometimes delirium, which is generally of a noisy, more or less violent character.

(2) The *asthenic* form indicates a graver depression of the patient's vitality, and occurs in those who are broken down in health by privation or dissipation, or in those who are suffering from organic disease of the eliminatory organs. In these cases the action of the heart is more rapid than in the sthenic form, the pulse beating from 130 to 150 a minute; it

is soft, thready, and compressible ; the temperature is also higher, mounting up to 104° F. or 105° F. ; the tongue is dry and covered with a brown fur, and sordes often collects on the teeth ; there is rapid emaciation and loss of strength. The skin feels burning hot and is dry ; the face flushed, and the eyes suffused. Delirium is more often present than in the sthenic form, but it is of a low muttering variety, and the patient often lies in bed in a semi-conscious state, and scarcely recognising those about him.

The treatment of acute inflammation.—In considering the treatment of acute inflammation, we must discuss its prevention and its cure.

Preventive treatment.—The term preventive treatment of inflammation is often used ; but it is not a good one, and is somewhat loosely applied. If inflammation is the 'response of living tissues to injury,' it is clear that we must have inflammation for the purposes of repair after every injury, and to prevent it would do incalculably more harm than good. What is meant by preventive inflammation is limiting the inflammation to its simple adhesive form, and preventing the occurrence of any of those sequelæ of the process alluded to above, such as suppuration, ulceration or mortification. And the way to do this is to, as far as possible, remove the cause and so prevent a continuance of the inflammation, and an excessive exudation of inflammatory products, which is the potent cause of these untoward results.

Now the various causes of inflammation may be summed up in the one word 'unrest,' and this may be either mechanical or chemical. Amongst the *mechanical* causes may be enumerated the presence of foreign bodies, the movement of parts, pressure, tension, gravitation from allowing a limb to hang and thus impeding the circulation. All these causes may be removed by attention to detail, and thus a condition of perfect rest obtained and a limitation of the inflammation to its simpler form. Amongst *chemical* causes are the various chemical products resulting from decomposition and the specific poisons of the various infective microbes. The former of these two we can prevent by excluding one of the factors of putrefaction, either the dead animal matter or the ferment, without which the process cannot be carried on. The infective micro-organisms, being sometimes admitted into the body by the respiratory and digestive tracts, we cannot always succeed in excluding by local means.

In this place we shall only consider the treatment of inflammation as applicable to cases where there is no wound, leaving the consideration of the treatment of inflammation arising from open wounds until we come to discuss these injuries.

We shall consider first the local and then the constitutional treatment of these cases.

Local treatment of inflammation.—Having as far as possible removed the cause, the first indication is to lessen the vascular engorgement of the part, for by this means we diminish the pain and reduce the amount of the exudation. There are several ways in which this congestion may be lessened, viz. by the application of cold or heat ; by local depletion, by position, or, as has been suggested by some, by ligature of the main artery of the limb.

The use of **cold** as a remedy for relieving the local congestion of an inflamed part is one of the most powerful which the surgeon has at his command, but at the same time it is one which requires using with discretion, since if too long applied or too intense it may lead to gangrene ; hence it should only be used very judiciously and in the early stages of the inflammation ; later on, when stasis has taken place, it may serve to precipitate gangrene. Cold acts by causing contraction of the blood-vessels, and therefore the immediate effect of its application is to lessen the amount of blood circulating in the vessels of the part, which becomes paler and colder. When intense or when applied for some time, it lowers the vitality of the tissues, and controls the amœboid action of the leucocytes and promotes the adhesion of the corpuscles and stasis. Under these circumstances it can only do harm, for it is desirable in inflammation that the blood should circulate rapidly in order to carry away deleterious materials from the part.

There are many ways by which cold may be applied : by compresses, by irrigation, by the application of ice, by Leiter's tube, or, to the body generally, by immersion or cold packing. The application of cold by *compresses* is not good. It consists simply in laying over the part a fold of lint which has been dipped into cold or iced water or wetted with some evaporating lotion. This plan of applying cold ought to be discarded, for either the lint, if left in contact with the inflamed part for a short time, soon becomes as warm as the part itself, or if it is frequently changed, the constant handling and interference with the part is productive of injury. *Irrigation* is an excellent plan of applying cold to some parts of the body, as, for example, the knee joint. A bottle containing cold or iced water is suspended over the part in a more or less horizontal direction and a skein of worsted or lamp-wick cotton is immersed in the water, the end being allowed to hang out of the mouth of the bottle over the inflamed part (fig. 4). The water will gradually drip from the end of the cotton over the part, which may be covered with a single layer of lint, so that the fluid is diffused all over the inflamed surface. Mackintoshes or trays must be so arranged as to carry off the water and prevent the patient's bed becoming wetted. This plan of applying cold possesses this great advantage, that it does away with the necessity of placing any heavy substance, such as a bag of ice or even a Leiter's tube, on the inflamed and sensitive surface, which is often a source of considerable pain and discomfort to the patient. The *ice bag* is another valuable means of applying cold, and has this advantage, that it is dry cold. For this purpose an india-rubber bag should always be used and not, as is frequently done, a bullock's bladder. This

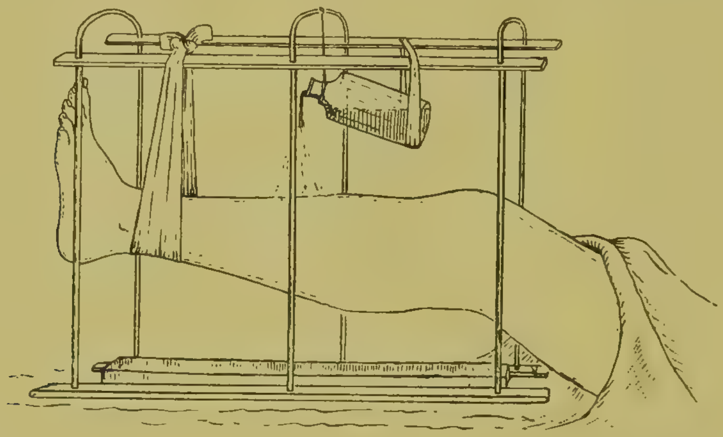

FIG. 4.—Diagram showing the method of applying irrigation to the leg.

latter allows the melted ice to pass through the animal membrane, and therefore the cold is not dry cold; and moreover india-rubber is a bad conductor of heat, and therefore the amount of cold applied is not so great as when a bladder is used, and consequently there is not the same necessity for constant supervision lest gangrene should supervene. *Leiter's tube* is also another means by which dry cold can be applied. It consists of a long leaden tube arranged in a coil, which can be moulded to the part. One end of the tube communicates with a receptacle of iced water placed above the patient's bed, whilst the other end is placed in some receptacle for carrying off the overflow (fig. 5). There is thus a constant circulation of cold water through the tubing and a continuous application of cold is maintained.

Immersion of the whole body in a cold or tepid bath has a very decided effect in lowering the temperature in general febrile conditions; and to some parts of the body, as the hand and forearm, or leg and foot, the same means can be applied locally; the great disadvantage of this form of applying cold locally is that the limb has to be maintained in a dependent position, which favours venous congestion. *Cold packing* is another means which is sometimes employed to lower the temperature in some febrile conditions, but is more frequently employed by the physician than the surgeon.

The application of **heat** to an inflamed part is another means of relieving congestion which is constantly resorted to. This it appears to do in a twofold manner. In the first place it increases the flow of blood through the part to which it is applied, and in this way acts in the opposite direction to cold, and not only tends to empty the vessels, but also carries away the deleterious products which are accumulating in them. Secondly, heat would appear to have some influence on the nerves of the part, lessening their sensibility, and thus leading to a diminution in the pain. Heat may be applied in many different ways. Dry heat is best applied by an india-rubber bag, containing a small quantity of hot water; or by the application of hot salt in a flannel bag. The salt should be heated in the oven to the required temperature and then quickly placed in a flannel bag, so as not to fill the receptacle, and laid on the affected part. The salt retains its heat for a very considerable time, and therefore does not require very frequent renewal. Heat may also be applied by passing hot water through a Leiter's tube; the water being kept at the required temperature by placing a lamp or gas jet under the receptacle in which the water is placed. Moist heat is applied by means of poultices or fomentations. The former of these is not a desirable means of applying heat in surgical cases, as they are made of an easily decomposable vegetable

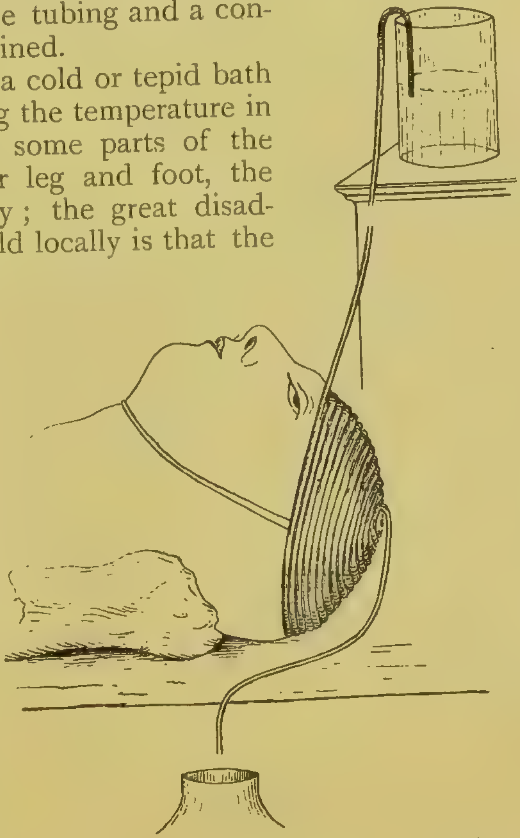

FIG. 5.—Leiter's tube as applied to the head.

substance, and therefore if a subsequent incision should be required the wound is liable to become contaminated. As a rule, therefore, the best means of applying moist heat is by fomentations, which consist of either flannel or lint which has been steeped in boiling water and then wrung as dry as possible. This is at once applied to the part and covered with a piece of mackintosh sheeting or oil silk so as to retain the heat as long as possible. The water may have added to it either anodyne or antiseptic drugs according to the requirements of the case.

Local depletion as a remedy for inflammation is one of the most important at the command of the surgeon, and possibly is not so frequently employed as its efficacy would appear to entitle it to. It serves to diminish the local congestion of an inflamed part, but the way in which it does this is not quite clear; it can scarcely be due to the effect produced by the abstraction of blood from the inflamed part, for sometimes the application of a single leech, which cannot be expected to abstract at the most more than half an ounce of blood, will produce a very appreciable result on the congestion of an inflamed part. It would appear to be probable that it exerts its influence by exciting a reflex act in the arteries leading to the inflamed part, as a consequence of the emptying of the vessels of the inflamed area itself—the reflex act causing a contraction in the arteries and a diminution in the supply of blood. There are several ways in which a local depletion may be brought about; viz. by leeches, by cupping, by scarification or by incision. *Leeches* are a convenient way of employing local blood letting. Each leech may be calculated to abstract about a couple of drachms of blood, and subsequent fomentation may produce a further couple of drachms, so that it is the custom to calculate half an ounce of blood as the amount which can be obtained by each leech. It is important to confine their operations to the affected part, and it is therefore customary to place them in an egg-cup or wineglass and then invert it over the part, which should previously be washed with a little milk, having been previously thoroughly cleansed. When the leech has filled itself, it will drop off, and the bleeding should then be encouraged by applying a hot fomentation. There is rarely any difficulty in stopping the hæmorrhage, which, indeed, usually ceases spontaneously; if not, it can generally be arrested by pressure. Sometimes in young children, especially if the leech has been placed over a subcutaneous bone, as the sternum, and in persons affected with hæmophilia, there is some difficulty in stopping the bleeding. Under these circumstances it can generally be controlled by inserting a fine needle across the base of the bite and winding a piece of silk around beneath the ends of the needle. This tendency of leech bites to bleed is said to be due to a secretion from the leech's pharynx, which retards the coagulation of the blood. *Cupping* as a means of local depletion is now seldom resorted to. The operation is performed by a special instrument, a 'scarificator,' which consists of a brass box, containing a spring to which are attached a number of lancet blades. When the instrument is *set* the blades are retracted within the box, but by touching the spring they are released and made to project through slits in the bottom of the box by a rapid rotary movement. If the bottom of the box is laid on the skin and the spring touched, each little lancet makes a scarification in the skin, which should not be so deep as to cut into the subcutaneous fat, otherwise the flow of blood will be prevented by the fat plugging the openings. The depth to which the knives cut can be regulated by a screw. As soon as the scarifications have been made, a dome shaped glass, having smoothly ground edges, the air of which has been previously exhausted by the introduction of the flame of a spirit lamp, is placed over the part. A vacuum having been thus formed in the glass, it adheres to the skin and the blood is sucked from the punctures into the glass. The operation is a somewhat painful and tedious one; requires a good deal of practice to perform with dexterity, and leaves permanent scars and therefore cannot be resorted to on exposed surfaces. There is a form of cupping which is known as 'dry' cupping, which is often very useful. It consists in applying the cupping glasses to the skin without making any previous incisions. It is useful in causing a determination of blood to the surface in order to relieve the congestion of some internal organ. Thus dry cupping in the loin is often very beneficial in relieving congestion of the kidneys following operations on the bladder or urethra.

Scarifications are occasionally very useful means of local depletion in the treatment of inflammation, as, for instance, in inflammation of the conjunctiva, for they have this further advantage in addition to the removal of blood, that they afford exit to the effused inflammatory products, and thus materially relieve tension. In the same category as scarifications may be mentioned punctures of small veins as a means of local depletion. This plan will be found exceedingly useful in inflammation of the testicle, where a small vein may be punctured in the scrotum and blood withdrawn with marked benefit in relieving the congestion and removing the pain. Where the inflammation attacks very dense tissues, and where the pressure of the exudation tends to entirely arrest the circulation, scarifications are not sufficient, but *incisions* must be made. In these cases the object of the incision is manifold: to locally abstract blood from the part, to get rid of effused products, and to relieve tension; and in these respects incisions are amongst the most useful means which the surgeon can employ in combating inflammation.

The **position** of the part is of paramount importance in the treatment of inflammation, and is a thing which should ever be present in the surgeon's mind in dealing with these cases. By elevating the inflamed part, and thus favouring the return of the venous blood to the heart, the local congestion may be very materially diminished and the pain relieved.

Finally, it must be mentioned that it has been proposed to relieve local congestion by cutting off the supply of blood to the inflamed part by ligaturing the main artery of the limb. Thus, in a case of acute traumatic inflammation of the synovial membrane of the knee joint, the superficial femoral artery has been tied at the apex of Scarpa's triangle. The remedy is, however, so severe that this plan of treatment is not likely to be often resorted to. A modification of it has, however, been suggested; to compress the main artery leading to the inflamed part. This, of course, can only be done where the artery is accessible.

Constitutional Treatment of Inflammation.—In the general treatment of inflammation, the same indications are to be followed as in the local treatment. That is to say, an endeavour must be made to remove all sources of irritation, and to diminish the vascular excitement of the part. The first of these objects is to be aimed at by maintaining, as far as possible, a condition of perfect rest, and removing all sources of external irritation, or annoyance, both bodily and mental; at the same time soothing the irritability of the nervous system by sedatives, such as morphia, the bromides, &c. The second object—namely, the endeavour to diminish the vascular excitement of the part—is to be attained by antiphlogistic remedies. These, however, are only required in those cases where the fever is high and the pulse full and strong in a young vigorous adult. In many cases where the patient is old or broken down in constitution by privation or dissipation an exactly opposite line of treatment is required.

The principal antiphlogistics which we possess are general blood-letting and certain medicines.

General blood-letting.—**Venesection** is not often called for in treating inflammation in surgery. Perhaps the only cases in which it is required are in cases of traumatic inflammation of the brain or its membranes, in which symptoms of brain pressure are present owing to the congestion of the cerebral vessels. There are, however, other instances in which general bleeding is of great value, as, for example, in cases of injury of the chest, where, owing to the interference with the respiration, the right side of the heart becomes loaded with blood. The object in venesection is to make a sudden impression on the circulation; the blood should always therefore be taken rapidly—that is to say, through a large opening, in a full stream, and with the patient in the erect position, so as to retard the flow of blood to the brain and induce faintness. General blood-letting is always performed in this country by opening a vein at the bend of the elbow, the ancient practices of bleeding from the external jugular vein, and of performing arteriotomy by opening the anterior branch of the temporal artery, are now things of the past. The vein which is selected at the bend of the elbow is usually the median basilic vein. There are certain anatomical reasons why this vein should be selected, and there are some reasons against its selection; but it will be found, as a matter of practice, that it is the best plan to select the largest vein in this situation, and this is generally the median basilic. This simple little operation is performed in the following manner. A piece of tape or bandage is tied round the arm above the point where the vein is to be opened, in order to constrict the superficial veins and arrest the flow of blood through them. This causes the veins below the ligature to stand out prominently. The patient, who should be seated, is now made to grasp something; a strong pole resting on the ground will do very well. By this means the limb is steadied, and the forcible muscular contraction aids the venous circulation. The thumb of the surgeon's left hand is now placed on the vein to be operated upon, just *below* the point where it is intended to open it. This will steady the vessel, and also control the bleeding at the moment of puncture and immediately afterwards (fig. 6). The point of the lancet is now pushed obliquely into the vein, and then made to cut its way out by de-

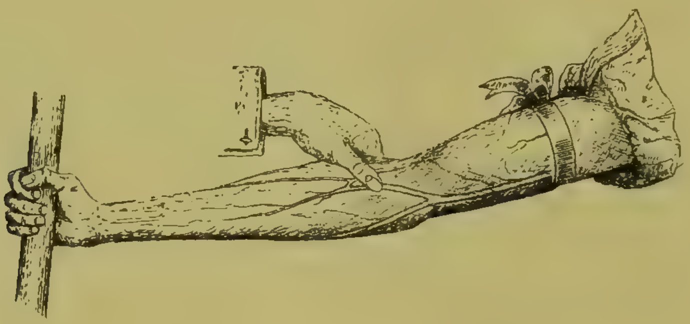

FIG. 6.—Venesection.

pressing the handle, and thus the opening in the skin will be larger than that in the vein, as the point of the instrument is made to describe a segment of a circle. The patient's arm is now turned over a basin or other receptacle for the blood, and the left thumb being removed from the vein, the blood will flow in a full stream. After sufficient blood has been withdrawn, the ligature around the arm is relaxed and a pad placed over the wound and secured by a figure of 8 bandage.

The most serious complication which may occur in the performance of this operation is a puncture of the brachial artery through the vein, leading to arterio-venous aneurism. This seems to have been an accident of by no means uncommon occurrence in former days. Sometimes a very painful neuralgic condition results, probably from some cutaneous nerve being involved; and, according to Hilton, 'bent' arm is occasionally the result when the median cephalic vein is selected for the operation, from injury to the cutaneous filaments of the musculo-cutaneous nerve, causing reflex spasm of the biceps and brachialis anticus. If the instruments are clean and proper care taken, septic inflammation can hardly occur, though in former days this was not uncommon.

Of *antiphlogistic medicines*, certainly one of the most useful to the surgeon in subduing local congestion is aconite. Given in minim doses of the tincture every half-hour for six or eight doses, it reduces the rapidity of the heart's action, and as a result diminishes the amount of blood sent to the inflamed part in a given time. Other antiphlogistic remedies are purgatives, especially saline purgatives, diuretics and diaphoretics, which abstract the watery constituents of the blood, and thus diminish the blood pressure generally.

The general treatment of inflammation in surgical cases aims rather at treating the symptomatic fever which is set up, and the treatment of this must vary according as to whether it is of the sthenic or asthenic type. In the *sthenic* form the indications are (1) to maintain the patient's strength by fluid food, such as milk and fluid preparations of meat, beef-tea, veal, mutton, or chicken broth. He can digest nothing else. Stimulants are not usually necessary or desirable. (2) To regulate the secretions, by the administration of purgatives, of which probably saline purgatives are the best, preceded or not, according to the requirements of the case, by a dose of mercury. (3) To endeavour to promote the excretion of the poison from the blood; for this certain specific drugs, termed antipyretics, may be used. Of these undoubtedly quinine ranks the first as the best and the safest; all the others, phenacetin, antipyrin, antifebrin, and salicylate of soda, are depressing, and must be given with caution.

In the *asthenic* form a more stimulating plan of treatment must be adopted. In these cases alcohol in some form or other is usually indicated and is often of the very greatest service, but it should always be given in small doses frequently repeated, rather than large doses occasionally administered. The diet must still be of a fluid character, but must be of as nourishing a kind as the patient can take, and must be given in small quantities at short intervals. For medicines in these cases, quinine, or bark and ammonia, are our sheet anchors.

As soon as recovery commences the patient may be put upon more or less solid food, and his diet should be light, but as nutritious as possible. A little wine, or even ale or stout, is now generally indicated, as it enables the patient to enjoy his food more and digest it better.

CHRONIC INFLAMMATION

In what has been said up to this point we have been considering inflammation as an *acute* process ; but there is another condition, which is known under the name of **Chronic inflammation,** which now requires to be considered. It is usually said to be a modification of the acute process, and so it is, up to a certain point, but still at the same time it differs very materially from it in some instances, and in this point in particular, that chronic inflammation may occur without any emigration of leucocytes, or, at all events, without there being any evidence of this migration having taking place. Still at the same time it seems to be true that we must regard the process as a modification of acute inflammation, for though we find the two extreme conditions of acute and chronic inflammation widely different from each other in all their features, still between these two extreme conditions there is a regular series of gradations, so that no hard and fast line can be drawn between acute inflammation on the one hand and chronic inflammation on the other, but the one condition gradually merges into the other.

Adopting then this view, that chronic inflammation is merely a modification of the acute, let us compare the process in the two conditions to see in what respects they differ from each other.

The first phenomenon which attended the acute inflammatory condition was dilatation of the blood-vessels and increased rapidity of the blood stream ; in chronic inflammation we note the same thing—there is a dilatation of the vessels of the part, but it is much more persistent, and sometimes leads to loss of tone and permanent dilatation. There is not, however, the same tendency to stasis as was noticed in the second change of acute inflammation. This no doubt is due to the fact that there has been less damage done to the vessel walls by the irritant, and therefore less alteration from their normal condition. It follows from this want of stasis that there is less emigration of leucocytes ; in fact, as we have already said, it would appear that there is no evidence of migration at all in some cases, whilst in others we find emigration going on, and accompanied by destruction of tissue.

In consequence of the slighter degree of damage to the vessel walls, they would appear to possess to a greater amount than in acute inflammations their selective influence, as to what should pass through their walls, and instead, therefore, of having a leakage of the plasma of the blood, we get merely a transudation of its serum, and hence we find serous effusions amongst the most common of the sequelæ of chronic inflammation. In the chronic form of inflammation, as in the acute, we after a time get the tissues outside the vessels crowded with cells, but the origin of these cells is not always the same ; in some instances, at all events, where no migration of leucocytes takes place, these cells are derived simply from the proliferation of the cells of the connective tissue of the part ; in others, no doubt where migration does occur, the new cells are derived in part from the emigrated leucocytes. These cells may undergo various changes, which to a certain extent resemble the changes which occur in acute inflammation. The most important and the most common of these consists in the gradual destruction of the tissue which is inflamed, and its replacement by young connective tissue. This formation of newly formed fibrous tissue is one of the most characteristic of the results of chronic inflammation ; it is often of considerable amount, and consists of a material which is very lowly organised, and it is very liable to undergo degenerative changes. It often leads in the first instance to great increase in size and thickening of the part, and then subsequently to diminution from contraction of the newly formed tissue. To this process is sometimes given the name of 'fibroid substitution.'

Other changes which take place in the cells which infiltrate and destroy the tissues in chronic inflammation are of a degenerative nature. (1) They may undergo fatty degeneration and form a cheesy mass. This may subsequently soften and acquire irritating properties, which leads to true suppuration. (2) Or the cells may perish from inanition, become withered and filled with fat granules, and form a granular mass, which subsequently softens and liquefies, forming a fluid which resembles pus, but in which there are no pus corpuscles. This process is known as *caseation*, and the collection of fluid thus formed is termed a *cold* abscess. (3) Again, in other cases, the mass of cells may shrink and dry up, and have lime salts deposited in it. It then forms a cretaceous mass which is harmless, and the process is known as *calcification*.

Causes of chronic inflammation.—The causes of chronic inflammation must be considered as predisposing and exciting, and of these the former are much the more important, as it is generally owing to the constitutional condition of the patient that a chronic inflammation is determined, for it is generally the result of some morbid process going on in the tissues. Thus we find that by far the most common cause of chronic inflammation is the presence of some infective disease, such as tuberculosis or syphilis, in the patient; that is to say, given some irritant, such as a slight injury, which in the healthy individual would be followed by a response, terminating in a few days in resolution; in a tuberculous and syphilitic constitution it terminates in chronic inflammation, which may last an indefinite period of time and result in the most disastrous consequences. Again, certain conditions of the blood, such as rheumatism and gout, may be the predisposing causes of chronic inflammation.

As regards the *exciting* causes, chronic inflammation may be said to be due to the result of an irritation of a low degree of intensity acting for a prolonged period of time. Thus the presence in the body of a foreign substance, as a bullet or a piece of dead bone, may be the exciting cause of chronic inflammation; or the obstruction of the duct of a secreting gland, or the retention of pus in some pocket or pouch after an abscess has been opened, so that it cannot readily make its escape, may act in the same way and set up chronic inflammation.

Symptoms of chronic inflammation.—The symptoms of chronic inflammation are the same as those which are met with in the acute form—viz. pain, heat, redness, and swelling, with modification of function. But they differ in degree, and are for the most part much less marked, and some of them may be altogether absent. In fact, in chronic inflammation the condition is often recognised more by the effect it produces rather than by the signs to which it gives rise. The *pain* of chronic inflammation is very variable; in some instances it is very slight, and partakes more of the character of tenderness than pain; in others it is very considerable, as in inflammation of hard, unyielding structures, such as bone or fibrous tissue. The *heat* is never very great, but there is always some increased heat over a chronically inflamed area, and this often becomes an important diagnostic sign. Take, for instance, a chronically inflamed knee joint in which there is pain on pressure or on moving the joint, without swelling or redness, this might easily be mistaken for a neurotic condition ; but if the sensation of heat, as conveyed to the hand placed over the joint, is compared with that of the other side of the body, it will always be found to be in some degree warmer, and this will at once establish the diagnosis. The *redness* of chronic inflammation is an unimportant sign; in fact, it is not present unless the part affected is superficial ; when it is present it is usually of a dusky hue, and is due rather to a condition of passive congestion than to the rapid circulation of an increased quantity of blood. Occasionally pigmentation of the tissues may be noticed, due to the disintegration of the coloured corpuscles which have escaped from the blood-vessels. *Swelling* is an important sign, and in some cases there is a very considerable increase in size ; but it depends here, not on the enlargement of the blood-vessels and increased quantity of blood, but on the formation of new products, and may after a time disappear and be followed by an actual diminution of size, as these new products undergo contraction. *Modification of function* is a very constant sign of chronic inflammation ; thus the movements of a chronically inflamed joint are restricted; the bladder when chronically inflamed is irritable, and unable to retain as much urine as in health ; the secretion of secreting structures is perverted, and so in every case of chronic inflammation the functional activity of the tissue or organ inflamed will in some way or other show some departure from its normal condition.

The **constitutional symptoms** in chronic inflammation are very variable. In some there are none present, whilst in others, in which they do exist, they are due to the causes which produced the inflammation rather than to the inflammation itself; that is to say, to the constitutional taint which has determined the chronic character of the inflammation.

Treatment of chronic inflammation.—The treatment of chronic inflammation can only be very briefly touched upon in this place, as the subject is a very wide one, and can be better discussed in connection with the various examples of it as affecting different tissues and organs which we shall have to consider hereafter.

The first indication, no doubt, is to discover and remove the cause. If this is due to some simple local irritation, as the presence of a foreign body, the treatment is manifest and in many instances easy. Remove the offending agent and the inflammation will cease. When, however, it arises from the irritation of some locally infective disease, as tubercle, a wider consideration is opened up, and the removal of the offending agent must depend upon a variety of circumstances which cannot be discussed in this place, but will be alluded to hereafter. When the chronic inflammation depends upon some peculiar diathesis or unhealthy condition of the system, as gout or rheumatism, the treatment will have to be directed to correcting this condition by constitutional remedies. In all cases the dietetic and hygienic management is of essential importance. The patient should be warmly clad and be kept in pure air, sea air being often the best, especially in tuberculous cases ; nourishing diet, of a light and easily digestible kind, should be ordered ; and the secretions should be regulated.

As regards the local treatment, the first and most important indication is *rest*, and the rest to be of any use must be absolute and complete ; no half measures are of much avail. In order to insure this the patient must if necessary be confined to bed, and this generally is necessary if the part affected is the lower extremity or the lower part of the trunk. If, however, the upper extremity is affected, perfect rest and immobility may generally be secured by some surgical appliance, and under these circumstances a strict confinement to bed need not be enforced.

Counter-irritation is another valuable means of treating chronic inflammation, though the precise mode of its action is not very clearly understood. Formerly it used to be taught, as the name implies, that by exciting inflammation in the skin, counter-irritation leads to diminution in the vascularity of the injured tissues, and this may be and no doubt is true in some cases. But in other cases it would appear to have a directly opposite effect, it actually increases the inflammatory action in the part itself, and by converting the sluggish chronic inflammation into an acuter form, and increasing the afflux of the blood and activity of the part, it brings about the termination of the process by resolution. The application of counter-irritants brings about results varying much in their intensity according to their nature, from a mustard poultice, which produces merely a reddening of the skin, to potassa fusa, which causes the death of the tissues with which it is brought into contact. Formerly a very large number of counter-irritants were in use by surgeons, such as mustard, capsicum, iodine, blisters, mercury, tartar emetic, croton oil, nitrate of silver, potassa fusa, the mineral acids, the actual cautery, issues, setons, moxas, but the two now commonly in use are blisters and the actual cautery.

The *blister* may be used either in the form of a plaister or in the form of solution which may be painted over the part with a camel-hair brush. The latter is perhaps the more cleanly and rapid way of producing vesication, but the former is rather more certain. When the plaister is used it should be applied to the part and maintained in position by a turn of bandage or a handkerchief and allowed to remain for eight or ten hours, by which time the bleb should be fully formed ; if this is not so, a light poultice may be applied to cause the blister to rise. When the plaister is removed the blister should be punctured in two or three places, to let out the serum and relieve the tension, but the cuticle which forms the bleb should on no account be removed, but allowed to separate of itself. The part should be dressed with a little boracic ointment, and it will heal in a few days. As soon as it has healed a second blister will in most cases be required, and even a third and a fourth, before a beneficial result can be obtained. This plan of applying what are termed 'flying' blisters is far to be preferred to the old-fashioned plan of keeping the blister 'open,' by applying savin ointment.

The *actual cautery* may be applied in two different ways. It may be used by heating a small button-head or a spear-shaped cautery to a dull red heat and applying it with the greatest possible rapidity and in the lightest possible manner to the inflamed part. The cautery is drawn rapidly over the inflamed area in parallel lines about an inch apart and these are crossed by other parallel lines at right angles to the first. It is only to be applied so lightly as to destroy the cuticle and leave the cutis vera uninjured. In cases of chronically inflamed joints, with great thickening of the synovial membrane, before destruction of the cartilage has set in, this plan of treatment is of the greatest use. The other plan of applying the cautery is to use an iron at a white heat ; this is applied so that a slough of the true skin is formed through its whole thickness. The slough is then allowed to separate and the sore kept open for some weeks with savin ointment. This plan of treatment is still adopted by some surgeons in chronic inflammation of joints where the cartilages are eroded and the articular surfaces of bone exposed, and there is in consequence great pain, with nocturnal startings, but the plan is not to be recommended. Another plan of treating chronic inflammation is to endeavour to get rid of the passive congestion which exists, either by the application of cold or by massage. The *cold* is best applied by douching or by placing the affected part under a running tap of cold water for a short time two or three times a day. In this way it acts very much more advantageously than by applying the cold continuously. For during its application there is a contraction of the vessels, and this is followed by a dilatation with increased flow through the inflamed part. *Massage* is of especial benefit in the treatment of chronic inflammation, not only in mechanically emptying the congested vessels of blood, but also in getting rid of the products of inflammation. It requires, however, to be applied with care and skill and in a different manner, according as to which of the two objects the surgeon has in view. While the inflammation is still going on and the object of the surgeon is to empty the congested vessels, the massage must be done by very gentle rubbing, always in the direction of the course of the venous circulation, the hand being pressed very lightly on the part. When, however, the object is to break up the exudation and force it into the lymphatic channels in the later stages of the disease, the massage must be done by a rapid circular movement, in which considerable pressure may be made, in order to break up the material, and this is to be followed by pressing upwards with the thumbs so as to force the broken-up material along the lymphatic vessels. Another exceedingly useful plan of getting rid of the effused material in chronic inflammation is by *pressure*. This can be applied in many different ways, by ordinary bandages, by elastic bandages or by strapping. Perhaps the most efficient way and at the same time the safest, is to swathe the part in a sheet of cotton wool and then apply an elastic webbing: by this means the pressure is uniformly distributed through the whole part. Martin's elastic bandage is a useful means of applying uniform pressure, but requires skilled care in its application, lest it be applied too tightly, and is apt to produce irritation of the skin if kept on too long. Strapping is an effective mode of applying pressure in some forms of chronic inflammation, such as in joints, in bursal enlargements and in orchitis, but it is often irritating to the skin, is very painful in its removal, if the part to which it has been applied is hairy and has not been shaved, and is sometimes followed by disastrous results if applied too tightly: as in a case recorded by Sir James Paget,[1] in which fatal cellulitis followed the application of a circular piece of strapping. In some cases, especially in chronically inflamed joints, pressure may be advantageously combined with counter-irritation. Perhaps the best known and the most commonly employed means of doing this is by 'Scott's dressing.' This is applied in the following way. Compound mercury ointment (Scott's) is spread on strips of lint and applied all over the affected part: over this is applied a bandage and then several layers of strapping in a uniform manner, so as to produce equable pressure, and over all is placed a starch bandage. By this means three objects are attained: the rubefacient and absorbent effect of the ointment, the pressure, and the physiological rest to the joint.

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[1] *Clinical Lectures*, p. 60.

SECTION II

GENERAL INJURIES

CHAPTER I

CONSTITUTIONAL EFFECTS OF INJURIES

Shock is that state of general depression of the vital activity which occurs after severe injuries, especially where there has been violent stimulation of the peripheral nerves and nerve endings; but may be induced also by some powerful impression applied to the nerve centres.

The commonest form of injury which produces shock is some force which damages a large number of branches of the sensory nerves; hence we find that it is especially liable to follow injury to those parts which are largely supplied with sensory nerves, as the head, the abdomen, the hand, the testicle, and the urethra. This is a point of considerable importance, because it would appear to have an important bearing on the most probable theory of the pathology of this condition. Numerous theories have been advanced at different times to explain the manner in which shock is induced, but the most feasible and the one most usually accepted is that it is a condition of exhaustion of the medulla and spinal cord following severe irritation of the peripheral terminations of the sensory and sympathetic nerves. It has been abundantly proved by experiment that over-stimulation of the peripheral endings of sensory nerves leads to exhaustion and temporary suspension of function of the corresponding centres, just in the same way that over-stimulation of motor nerves leads to fatigue and suspension of function in muscle. So it is believed that some injury, that is to say over-stimulation, of the peripheral nerve endings produces a condition of exhaustion and partial suspension of function in the centres of the medulla and spinal cord, which causes a great depression in the general vital activity. So it follows that injury to those parts which are largely supplied with sensory nerves, that is to say, injury to a large number of nerve endings, is followed by more exhaustion of the nerve centres, and therefore more shock, than injury to those parts which are not so largely endowed with sensation. We therefore find that the most common form of injury which produces shock is some crushing force which damages a number of branches of sensory nerves, and that very often the amount of shock depends on the extent of the injury rather than on its depth and degree.

The extent and amount of shock are influenced by certain conditions. Thus old people, who are the subjects of degenerative changes, and young children suffer severely from shock; as do also patients of a neurotic or excitable temperament. Previous loss of blood by depleting the nerve centres acts as a predisposing cause; but on the other hand an antecedent illness, which has simply confined the patient to bed, without causing any organic change in the viscera, is a prophylactic against shock. A patient who has been confined to bed for a long time, let us say, with chronic joint disease will stand a severe operation without shock, always providing that there is no lardaceous change in his viscera, under which circumstance extreme shock is to be anticipated.

Symptoms.—Shock generally comes on immediately after the receipt of the injury; but in some cases, especially those in which there is great mental excitement at the time, it may be delayed for an hour or two. Accordingly we find that on the battlefield and after railway injuries, where the patient is in a state of extreme mental excitement, no signs of shock may present themselves at first. The patient is often able to move about, unconscious that he has received any injury, and the symptoms may be delayed for an hour or two and then come on insidiously, the patient gradually passing into a condition of shock. When present the patient lies in a state of semi-consciousness, able to answer questions when spoken to, but lying, with half-closed eyes, apparently taking no notice of what is going on around him. The surface of the body is pale and cold, with beads of perspiration about the head; the pupils are usually dilated; the respirations are feeble, shallow and irregular; the pulse is small and feeble, sometimes scarcely to be felt in the radial artery, and is generally slowed at first below the normal rate, but after a time becomes accelerated: this is usually regarded as an indication of reaction. The temperature is subnormal, the thermometer usually registering from one to two degrees below the normal temperature of the body. There is complete muscular relaxation and apparently incoherence of thought and speech.

Where the shock is about to terminate in death, the patient gradually becomes more and more unconscious, until at length he arrives at a state of stupor from which he cannot be roused, and dies. In cases of recovery, reaction takes place in from two to twenty-four hours. The skin becomes sensibly warmer, the patient becomes more conscious, begins to look about him and answers questions with more readiness. Movements, at first irregular and feeble, take place and the respirations become fuller and the pulse stronger and its rate of beating quicker. The temperature rises to slightly above normal, but speedily falls again.

Cases of 'shock with excitement' have been described, in the first instance by Travers, in which the patient is restless, talking volubly and incoherently. Apparently insensible to pain, he tosses himself about and attempts to get out of bed; the skin is hot, the respirations hurried, and the pulse quick. After a time symptoms of depression come on and the patient lapses into a state of stupor and almost invariably dies. These cases were regarded by Travers as instances of premature and excessive reaction. They are, in the present day, exceedingly uncommon.

Treatment.—In the treatment of shock, very much must depend on its severity. In slight cases very often the less done the better. The patient should be kept in a state of perfect quietude and rest, relieved from all sources of annoyance, such as noise, a strong light, &c. He should be kept warm by being wrapped up in blankets, and by hot-water bottles placed in his bed. The popular practice of giving stimulants in these cases cannot be too strongly condemned; a cup of hot beef tea will do as much good in promoting warmth and restoring the circulation, and is infinitely less likely to do harm. If, however, the patient appears to be in danger of instant death, active measures must be resorted to. Here, again, rest and warmth are essential; the head should be kept low, and surrounded with flannels wrung out in very hot water and constantly renewed; the body should be swathed in blankets, and hot-water bottles should be applied to the extremities. Small quantities of brandy should be administered by the mouth, at short intervals, if the patient can swallow, and by the rectum, diluted with hot water, if he cannot, and ammonia applied to the nostrils. Galvanism over the præcordial region is often efficacious in stimulating a flagging heart. Perhaps the most useful agents which we possess in rallying patients from extreme shock are the subcutaneous injection of strychnia and ether. Of these, strychnia is the better, and $\frac{1}{30}$ of a grain injected hypodermically is often followed by the most satisfactory results. Ether, injected in half-drachm or drachm doses, is also a potent agent, but its use is often followed by the formation of troublesome sores at the spot of injection. When shock is combined with loss of blood, normal saline solution (a drachm of common salt to a pint of sterilised water at a temperature of 100° F.) should be injected into the veins or rectum. For my own part I strongly advocate its injection into the rectum, and in my hands the introduction of two or three pints of saline solution into the rectum has been followed by the most satisfactory results.

Prevention of Shock during Operations.—The first essential point in preventing shock during operations is the maintenance of the warmth of the patient's body. The room in which the operation is performed should be warm and the table heated. This can easily be done by placing on the table a water pillow containing hot water. No unnecessary exposure of the patient's body should be allowed; all parts except the one to be operated on should be swathed in flannel. In children it is a good plan to swathe the whole body, except the part required for operation, in a thick layer of cotton wool, fixed on with flannel bandages. No unnecessary delay or protraction of the operation should be permitted, everything likely to be required being at hand before the operation is begun; the proceedings commenced as soon as the patient is thoroughly under the influence of the anæsthetic, and proceeded with as rapidly as is commensurate with its proper performance. In cases where shock may be expected, it is a good plan to inject a dose of strychnia under the skin before the operation is commenced, and it is often of advantage to introduce three or four ounces of hot brandy and water into the rectum as a means of averting shock.

As regards the question whether operations should be performed whilst a patient is in a condition of extreme shock, I think it is better and wiser not to operate, unless there is some urgent necessity for it, such as hæmorrhage which is endangering life, and which requires an operation for its arrest, and under these circumstances no anæsthetic should be given. I have seen operations performed upon patients in a condition of extreme shock, without the slightest manifestation of pain.

Secondary Shock.—The older authors described a condition which they termed secondary shock, in which a patient, some twenty-four or forty-eight hours after rallying from the shock of an injury, again suddenly developed marked symptoms of this condition, and usually died in a few hours. The condition is rarely seen now, and was probably due to intense septic intoxication.

Syncope must be distinguished from shock. It may be defined as a state of suspended animation, due to sudden failure of the heart's action, producing anæmia of the brain. It may occur without any injury; from emotional causes, such as fear, grief, or joy; from intrinsic cardiac conditions, such as fatty degeneration of the heart, or depression of the heart from hunger or exhaustion; from a hot, impure atmosphere, when it appears to be caused by interference with the respiration and secondarily with the heart, from the presence of carbonic acid in the blood; and finally, syncope may be caused by sudden loss of blood.

Symptoms.—When a patient is about to faint, he becomes suddenly pale, and suffers from a sense of giddiness, with singing noises in the ears and partial loss of sight. The pulse is weak, small and quick, and the respirations shallow and feeble. This is followed by a rapid disappearance of sensory impressions, the muscles become relaxed and the patient falls, completely unconscious. He now lies in a state of apparently suspended animation; the face is deadly pale, the eyes closed, the pupils widely dilated, the pulse is imperceptible or scarcely to be felt, and the respiration is indistinguishable. After a longer or shorter time, the patient makes one or two slight sighing respirations. Some feeble movements are made, the colour begins to return to the face, the pulse can again be felt at the wrist, and he gradually recovers consciousness. In other cases of faintness, especially from disease of the heart, the syncope may terminate in death, and on post-mortem examination the heart will be found to be uncontracted, the ventricles being either full of blood, or empty in those cases where the syncope is due to hæmorrhage.

Treatment.—The indications for treatment are to lay the patient flat on his back, in order to favour the flow of blood to the brain; to improve the action of the heart by friction over the præcordial region, or if a battery is at hand, by galvanism, to apply smelling salts to the nostrils, and to give a little brandy, as soon as the patient can swallow.

TRAUMATIC FEVER

The term **traumatic fever** is applied to febrile excitement which follows closely upon any severe injury, that is to say, occurs within the first week or ten days, but is not applied to those forms of fever which accompany a true infective process, such as erysipelas. This fever presents itself under two perfectly distinct forms, which it is necessary to differentiate carefully from each other. It has been incidentally mentioned in speaking of shock, that, as reaction takes place, the temperature, which during the shock was subnormal, generally rises above the normal point but speedily falls again. This slight increase of temperature, which is generally unaccompanied by any other febrile symptom, is spoken of as *aseptic traumatic fever*, or by Billroth, as *primary traumatic fever*: it would appear better, if the condition merits a name at all, to call it *reactionary fever*, and to confine the term traumatic fever to the other condition, which is due to absorption from a wound of septic products which have been developed by the bacteria growing in it. This is commonly known as *septic traumatic fever*, or following the nomenclature of Billroth, *secondary traumatic fever*.

In order to illustrate these two conditions, let us take a case of severe injury, such as a compound fracture of the leg. At the time of admission into hospital, the patient is in a condition of shock, and the temperature is subnormal; as soon, however, as the patient begins to rally, the temperature begins to rise, and very shortly reaches the normal point; it does not stop there, but continues to rise until it reaches, let us say, a point two degrees above normal, never much more. When we visit our patient the next day, we find that he has a temperature perhaps of 101° F., and this may be all. In a slight case there may be no other febrile symptoms, the patient may have no headache, no acceleration of the pulse, and is not conscious of any feeling of illness. If the wound remain aseptic the temperature speedily begins to fall, and in the course of three or four days, or even less, reaches the normal point. This is the so-called aseptic traumatic fever. But supposing serum and blood have been allowed to remain in the wound, and bacteria have been admitted to it, putrefaction sets in, and chemical products (*ptomaines*) are formed as the result of this fermentative process, and are rapidly absorbed into the blood, giving rise to true traumatic fever (*septic traumatic fever*). The temperature again rises, it may be before it has reached the normal, when the primary fever is masked by this secondary fever, and the patient presents other symptoms of febrile excitement. The temperature rises rapidly, and attains a much higher degree than it did in the primary attack, often reaching 103° F. or 104° F. (fig. 7). The skin is hot, the face flushed, the pulse accelerated, the tongue furred, the secretions diminished, and there is often delirium. It will be seen that, in these cases, the fever does not commence until some time after the injury, generally on the second or third day, until, indeed, the putrefactive process has been established; it generally reaches its highest point about the third, fourth, or fifth day, and then remains at the same height, until about the ninth or tenth day, when a considerable defervescence usually takes place. This is to be attributed to the formation of granulations, which, as we have already mentioned, act as a barrier to the

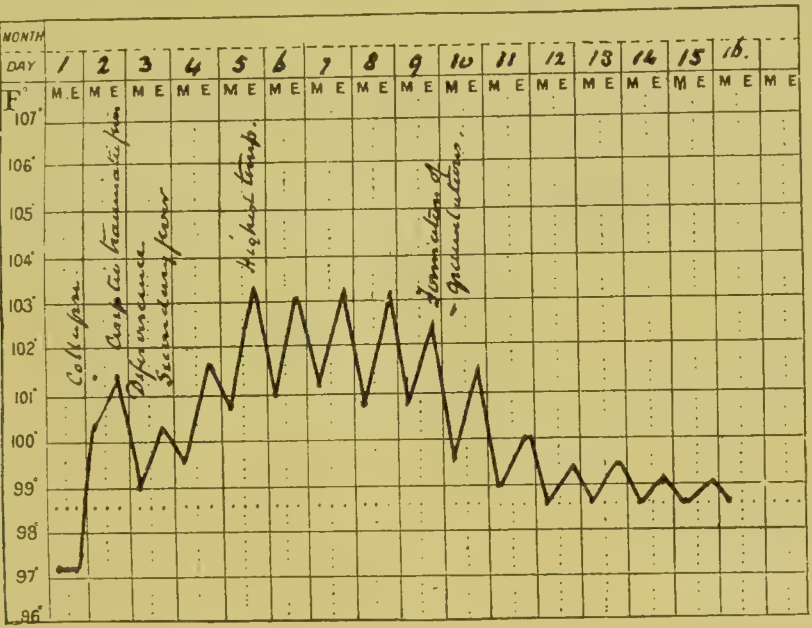

Fig. 7.

Chart of the temperature in a case of septic traumatic fever.

absorption of the noxious products into the blood, and which, by this time, have probably coated the surfaces of the wound.

The amount of traumatic fever is always proportional to the amount of ptomaines absorbed. When the wound is large and the quantity of decomposing material is great, and especially if pent up and subjected to pressure, which increases the rapidity of absorption, a condition known as sapræmia or septic intoxication is set up. In these cases the temperature rises very rapidly and attains a maximum of 104° or 105°; there is great prostration, with a rapid, feeble pulse, nausea and vomiting, frequently diarrhœa, rapid emaciation, and the patient falls into a condition of collapse and dies. Again, in other cases, the temperature does not fall when the wound granulates, or if it has fallen, it again rises; under these circumstances probably pent-up decomposing matter is still retained in the wound, under a certain degree of pressure, and a condition of 'hectic' is set up, which will be referred to hereafter.

Treatment.—In aseptic traumatic fever no treatment is necessary, the condition is of an exceedingly transitory nature, and the natural tendency is to recovery. The patient should simply be kept on a fluid diet until the temperature becomes normal, and it may be advisable to administer a purgative, if the bowels are confined. The treatment of the septic form consists in getting rid of the cause of the condition by cleansing the wound of all putrefying material, and if this can be done the fever will quickly subside. In order to do this it may be necessary to reopen the wound, if it has been closed, and possibly to enlarge it, to irrigate it thoroughly with some antiseptic fluid, of which corrosive sublimate solution (1 in 2,000) is perhaps the best, and to endeavour to get rid of any fluid locked up in the part by careful and efficient drainage.

Traumatic delirium.—A delirious condition may sometimes follow surgical operations and injuries, and this may depend upon three distinct causes. 1. It may occur in cases of septic traumatic fever, and is then due to the circulation in the brain of the products of the putrefactive changes which are going on in the wound. It is usually termed *Inflammatory traumatic delirium*. It usually shows itself from the third to the fifth day after the injury, when the traumatic fever is at its height and is accompanied by increased fever. The delirium is sometimes of a violent character, but usually there is only wandering of the mind and incoherent talk during the night, the patient answering questions rationally during the day. The treatment consists in local measures to get rid of pent-up discharges in the wound, a purgative to clear out the bowels, a light, nutritious diet, and an ice cap to the head when the fever is high. 2. A form of traumatic delirium is occasionally met with, which almost exactly resembles delirium tremens, but which is not due to excessive drinking, in patients exhausted by brain work, or of highly nervous temperament. The delirium in these is usually of a low muttering character, but is occasionally maniacal and is said to differ from true delirium tremens in the absence of the tremor of the muscles, which is one of the characteristic signs of the delirium of drunkards. These cases are generally relieved by inducing sleep by means of narcotics and by the careful use of stimulants, which are generally indicated, especially when the delirium has been caused by over-exhaustion of the nervous system. 3. By far the most common cause of delirium after injury or operation is the habit of excessive drinking on the part of the patient, and is, in fact, true delirium tremens occurring as a complication of a surgical case. The symptoms usually commence with want of sleep and a nervous, restless, excitable manner. A peculiar tremor sets in, affecting all the muscles, but especially the hands, the tongue and the lips. If the patient is requested to protrude his tongue, it will be seen to be in a constant tremulous agitation, and he will often close his teeth upon it, in order to check its movements: in the same way the hands will be seen to present the same tremor, and the patient will be noticed to be constantly picking at the bed-clothes, to be arranging them, or to be 'busy' about something. He is always doing something, is constantly muttering or talking to himself, and generally has one dominant idea. He frequently has delusions, sees animals creeping about his bed or in the room and is ever trying to get rid of them. Occasionally he is violent, tries to get out of bed, and even attempts to destroy himself. The general condition is not one of fever, the temperature is not as a rule raised; if it is, the case at once assumes a grave aspect, as in fatal cases the temperature sometimes rises rapidly just before death. The skin is usually bathed in a profuse perspiration, the tongue is white and furred, and the pulse quick, soft and compressible. The sleeplessness continues and the patient generally refuses food, though he will take fluid. Death may occur very rapidly in fatal cases, or the patient may live some days and die of exhaustion.

Treatment.—The chief points in the treatment of these cases is to procure sleep and to support the patient's strength. In the premonitory stage, before delirium has set in and when there is merely restlessness and sleeplessness, with possibly tremor of the muscles, a good brisk mercurial purge, followed, after its action, by the subcutaneous injection of a $\frac{1}{4}$ or a $\frac{1}{3}$ of a grain of morphia, may be all that is necessary; the patient will fall into a sound sleep and awake quite well. When the disease is thoroughly established, the same line of treatment should be pursued, but it will generally be found that it will require more than one dose of the sedative, before sleep is induced. There can, I think, be no doubt that morphia is the best form of sedative, unless indeed the patient is the victim of kidney disease, when it should be given, if given at all, with extreme caution. The best way to administer it is by subcutaneous injection, as when given by the mouth it may perhaps not be absorbed. Four or five doses of a quarter of a grain, given at intervals of four hours, rarely fail to procure sleep. Other sedatives are bromide of potassium alone or combined with chloral hydrate. The bromide alone is not very reliable, and the administration of chloral hydrate is not always devoid of risk. Cases have been recorded where a large dose of this drug has been followed by sudden death from cardiac syncope. In cases of advanced kidney disease probably hyoscyamus or its alkaloids is the safest drug to employ. When sedatives fail to procure sleep, it has been recommended to place the patient under chloroform and then follow up its effects by the subcutaneous injection of morphia.[1] But this is another plan of treatment which entails a certain amount of risk, and cases have been recorded where it has been followed by the death of the patient. The diet should consist of light and nourishing food: milk, beef-tea, strong soups and eggs, and if there is depression, a certain amount of stimulants. Very considerable difference of opinion exists amongst surgeons as to the propriety or not of administering stimulants in cases of delirium tremens. For my own part I would draw no hard and fast line. If the patient is young and vigorous and it is a first attack, probably no stimulants will be required; but if the patient is old or, what is more likely, prematurely aged and broken down in constitution by his intemperance, I believe that alcohol is absolutely required, but it should not be given in the enormous quantities with which it was the fashion some years ago to treat these cases, but in small and frequently repeated doses. A teaspoonful or a couple of teaspoonsful of brandy given every two or three hours has a far more decided and beneficial effect than a larger dose given at longer intervals.

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[1] Morant Baker, *St. Bartholomew's Hospital Reports*, xix. 249.

Remote constitutional effects of injuries.—Constitutional effects of a very varied character are liable to be set up by severe injuries, and these are usually to be traced to some functional derangement of the nervous system, which manifests itself after the local injury has been completely recovered from, the patient never appearing to entirely regain his normal condition of health. This condition is known under the name of **Traumatic Neurasthenia.** It most frequently occurs in those persons whose general health is lowered at the time of the injury, either from organic disease, or from overstrain produced by prolonged work, or privation, or deficient sleep, &c. It also appears to be more common in females than in males. The symptoms characteristic of this condition may not come on for some considerable time after the injury, but it will always be found that there has never been a complete restoration of health from the time of the accident to the occurrence of the more pronounced symptoms, though the local effects of the injury may have long passed entirely away. This condition manifests itself in various ways, but especially in derangements of the circulatory and vaso-motor systems. The patient complains of a feeling of general malaise, and his appearance shows that he is not well, he looks wan and ill, and there is often an expression of anxiety on his face. He is restless, is unable to fix his attention on any occupation, and complains of early fatigue and exhaustion if he attempts to do any work, either mental or physical. His sleep is disturbed and broken, and he often suffers from frightful dreams. There is great nervousness, the patient starts at any sudden noise, often loses control over the emotions, and will on the slightest cause, and sometimes without any cause at all, burst into fits of hysterical crying. He is also depressed and despondent. Combined with these symptoms there is palpitation and irregular action of the heart, impairment of the general muscular power, coldness of the extremities from defective nutrition, sensations of heat and cold, and sometimes excessive sweating.

If there is no organic disease, recovery, in the majority of cases, is complete, but in others a permanent condition is set up from which the patient never recovers, and cases have been recorded where death has supervened suddenly from failure of the heart's action some months after the accident, and in which, on post-mortem examination, no lesion of the nervous system has been found.

The treatment in these cases consists essentially in rest, good air, and good food. The patient should be sent into the country, and should pass his time as much as possible in the open air: he should abstain from all work, either mental or physical, but especially the former, and should have light, easily digestible food in small quantities at frequent intervals. With regard to medicines, no drug has any special influence on this condition, but tonics, by improving the general health, assist in bringing about recovery: of these, Easton's syrup, combined with dilute hydrobromic acid, is perhaps the best.

CHAPTER II

INJURIES AFFECTING SOFT PARTS

Contusions.—Contusions may be defined as subcutaneous lacerations, the skin remaining unbroken. It is in this last essential particular that a contusion or bruise differs from a wound: in both there is a laceration, or solution of continuity of tissue, but in the wound the solution of continuity involves the skin and therefore air and any noxious materials which it may contain are admitted to the lacerated structures, whereas in bruises, the skin remaining unbroken, no noxious matter can be admitted from without. In every case of contusion there must be extravasation of blood, because amongst the injured tissues there must be blood-vessels which have been torn and from which blood has escaped; but the extravasated blood may be said to be contained in an hermetically sealed case to which no germs can be admitted from without, hence it follows that suppuration rarely occurs. The amount of extravasation which takes place depends upon the extent of the rupture and the vascularity of the part injured.

Contusions or bruises vary very much in extent. (1) There may be a simple bruise of the deeper layers of the skin and subcutaneous tissue. In these cases there is swelling of a dull red colour, which speedily becomes dark brown, chocolate or black, according to the quantity of blood effused and the structure of the part. In very loose, connective tissue such as the eyelid, the scrotum or the vulva, the part speedily becomes black; whilst on the scalp, where the skin is thick and strengthened by the aponeurosis of the occipito-frontalis, there is scarcely any perceptible change in colour: on the front of the eye, where the conjunctiva allows the free passage of air, the colour is scarlet. Accompanying this swelling and discolouration, there is pain of a dull, aching character, from the bruising and laceration of the nerve endings.

As the extravasated blood becomes absorbed, the black colour of an ordinary bruise on the surface of the body changes into green and then yellow. This is due to the disintegration of the coloured corpuscles, which break up, and becoming absorbed leave behind them the blood pigments, which undergoing changes, give to the part its characteristic colouration, which lasts for some time before the skin regains its normal appearance.

(2) In severer cases of contusion, the blood, instead of distending the spaces of the subcutaneous areolar tissue, is contained in a sort of cavity or bag, caused by the breaking down of the tissue. To this condition the generic term of *hæmatoma* is given. Here a definite space or cavity has been formed, into which the blood is poured out, and here it may remain fluid for weeks or months undergoing very little change. In these cases a definite tumour is formed which fluctuates, and in which, when the injury is somewhat deeply seated, there is no discolouration. These

cavities are frequently surrounded by a wall formed of blood clot and condensed tissue, and under these circumstances present a hard circumscribed border, with a soft, fluctuating centre. When such a hæmatoma occurs on the scalp, it is liable to be mistaken for depressed bone; the hard abrupt border of the circumscribing clot feeling like the hard edge of a broken bone. Hæmatomata are frequently mistaken for chronic abscess or for malignant disease, but the history of the case and the occurrence of the swelling immediately after the accident, together with the absence of the other signs of inflammation, are sufficient to establish the diagnosis from abscess, whilst the stationary nature of the swelling, instead of the progressive increase of malignant disease, should at once differentiate it from this condition. Should any doubt exist, exploration with an exploring syringe or a grooved needle and examination under the microscope will at once clear up the matter.

(3) In some instances the contusion is so severe as to lead to the destruction of the vitality of the part and to the occurrence of sloughing, and under these circumstances, unless care is taken to maintain perfect asepticity, we may have profuse suppuration, with throwing off of sloughs of cellular tissue and, it may be, destruction of muscles and even vessels, when fatal hæmorrhage may occur. In some instances of contusion from crushing force or great violence, we may have the vitality of a whole limb destroyed; then it falls into a state of rapid gangrene, without the skin being broken: this is especially the case where the main artery of the limb is injured and where the effused blood which is poured out from it presses on the other vessels and prevents a collateral circulation being set up.

Treatment.—There are two indications to be followed in the treatment of contusions. (1) To prevent as far as possible the further extravasation of blood, and (2) to promote the absorption of the blood already effused. The principal agent which we have for preventing the further extravasation of blood is cold. This causes contraction of the torn ends of the vessels and assists in the formation of coagula in them and thus arrests the hæmorrhage. Cold may be applied by cold douching; by the application of ice, which however must not be continued too long, for fear of sloughing of the bruised tissues; or by cold evaporating lotions. Tincture of Arnica painted over the part, or diluted with five times its bulk of water and applied as a lotion, has also been recommended. As soon as all increase in the swelling has ceased, and therefore, it may be assumed, all hæmorrhage has stopped, the application of cold is of no further use. Now it will be found that massage will be the most efficient plan of promoting the absorption of the extravasated blood. This should be done very gently at first and should be conducted by light pressure with the hands in the course of the venous circulation. As absorption takes place the massage should be more vigorous; if the contusion has involved a joint or joints, passive movements should be combined with the massage in order to prevent stiffness, and if muscles have been implicated, kneading should be employed so as to restore their tone. Another useful means for promoting the absorption of the extravasated blood is pressure, an ordinary bandage, or a bandage which has been soaked in Goulard lotion and which is constantly kept wet with the same lotion, or a Martin's india-rubber bandage may be applied to the part, and will often prove a most efficient aid in promoting absorption. They must be applied with care and not too tightly, lest they should further obstruct the already embarrassed circulation and lead to gangrene. Where a hæmatoma has formed and does not rapidly show any tendency to diminish, it is better to at once freely incise it, turn out the fluid blood and clots and insert a drainage tube. In these days of aseptic surgery, with proper precautions, there is no risk in doing this, and therefore there is no object gained in losing time in waiting for absorption, which may probably never take place. In former days such a practice as this would have been regarded as fraught with danger.

Blood cysts.—In some cases of hæmatoma where the blood is not absorbed and is allowed to remain, a sort of cyst is formed, which is termed a *blood cyst.* The process appears to be somewhat as follows: a slow process of coagulation takes place and the fibrin thus formed becomes deposited as a thin layer on the tissues surrounding the cavity. This forms a framework, into which large plasma cells, derived from the connective tissue corpuscles, emigrate, and undergoing development become converted into fibrous tissue, which gradually absorbs the blood pigments; so that eventually we have a cyst, consisting of a well-formed fibrous wall and containing clear serum. This cyst may remain indefinitely. Such structures are occasionally found in the sub-dural space of the cranium, and as was first pointed out by Sir Prescott Hewett were originally extravasations of blood in this situation.

Subcutaneous wounds.—It would appear to be expedient under the heading of contusions to consider subcutaneous wounds, since in their behaviour they partake far more of the character of a bruise than they do of an open wound. They are wounds in which a very considerable extent of tissue is divided through a mere puncture in the skin, which is immediately closed, so that they enjoy to a great extent the characteristics of a bruise; viz. that there is a subcutaneous solution of continuity to which air, and any impurities it may carry, is not admitted. They are generally made by the surgeon, and were formerly in much more common use than they are in the present day. Nowadays when a surgeon employs strict asepticity in his operations there is not the risk from open wounds that there used to be, and there is not the same necessity for resorting to such measures as subcutaneous surgery. It need hardly be said that the open method of performing an operation possesses its advantages, as the surgeon can be much more exact in its performance, simply dividing what is necessary and no more than is necessary. A subcutaneous operation, such as tenotomy, consists in introducing a very narrow knife through a mere puncture in the skin, then by turning the cutting edge of the knife against the structure to be divided and depressing the hand a free sweep of the tissues is made, forming a subcutaneous wound: on the withdrawal of the knife the wound is immediately closed by a compress to prevent the admission of air. The small external wound heals at once, and the tissues beneath behave as a subcutaneous laceration or bruise.

WOUNDS

Wounds may be defined as solutions of continuity, dividing the skin and thus permitting the admission of air to the injured tissues. There are many different kinds of wound, and for purposes of description they may be divided as follows: 1. *Incised* wounds, where the injury is produced by a sharp cutting instrument; where the length bears a considerable proportion to the breadth and the edges are clean cut. 2. *Contused and lacerated* wounds, where the edges are torn and ragged and the tissues around bruised and infiltrated with extravasated blood. They are usually caused by a blunt instrument. 3. *Punctured* wounds, in which the depth much exceeds the length, as in a prick or stab. 4. *Poisoned* wounds, where some poison is introduced into the wound. 5. *Gunshot* wounds, resulting from the action of 'missiles that have been projected by force derived from explosion.'[1]

Before we enter upon a description of these several varieties of wound, it is desirable that we should take into consideration the various ways in which wounds heal, as it will help to elucidate what will have to be said in the future.

UNION OF WOUNDS

In former days five different methods were described by which a wound might unite: viz. (1) by immediate union, primary adhesion, or direct growing together of the severed surface; (2) by first intention, or adhesive (retrogressive) inflammation; (3) by scabbing; (4) by second intention, or granulation; and (5) by secondary adhesion or growing of two granulating surfaces together. To these five modes of union recent pathologists have added another, namely 'healing by blood clot,' to which I shall refer in the sequel. It seems to me to be much simpler and more in accordance with the true facts to describe the modes of union as two in number, namely (1) union without suppuration and (2) union with suppuration, and it will be my endeavour to show that the five classical modes of union of wounds may be arranged under these two heads; and moreover that the difference between these two modes of union is very slight, and is one rather of degree than of kind, and that they are both the result of the same pathological process going on in the part.

1. **Immediate union.**—When the edges of a perfectly clean cut, such as that made in the operation for hare lip, are carefully brought together and adjusted, without the intervention of any foreign body, and are kept in apposition for a sufficient length of time, free from all external sources of irritation, union may take place, without any appreciable signs of inflammation, and in the course of forty-eight hours or so the wound may be so soundly united as to require no further attention. The only indication of the wound will be a slightly red linear mark, which speedily disappears and eventually no trace of it is left. These cases were first described by Macartney of Dublin, as cases of union of wounds *without* inflammation; that is to say, union took place without any intervening substance such as blood or lymph. This theory of Macartney's has been revived in the present day, and there are many pathologists who affirm that union of wounds is a physiological process, and takes place entirely without the occurrence of any inflammation. I cannot bring myself to believe that this is so. It would be impossible in this work to enter fully into a discussion on this question, but I may mention that it seems to me that the strongest argument against the theory is that the bond of union which unites the severed edges, however brought about, is a more lowly organised material than the original tissue which was injured, showing that there has been retrogression, or impaired vitality, which is the natural result of the inflammatory process. Of course if we adopt Burdon Sanderson's definition of inflammation, the whole argument falls to the ground, as every injury must be followed by inflammation for the purposes of repair. I

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[1] Longmore, *System of Surgery*, third ed. p. 461.

regard these cases of so-called 'immediate union' as cases in which the inflammation is slight and in which the exudation is small and perhaps only to be recognised by microscopic examination. Direct experiment supports this conclusion. If a very small incision is made in the cornea of a rabbit with the sharpest knife, and is prevented from gaping by at once closing the eye, it will be found to have healed in a few hours and no trace of the wound will be visible to the naked eye; but if the animal is killed and sections cut across the wound, the intermediary substance may be demonstrated by microscopic examination.

2. **Union by first intention.**—This mode of union, which was described by Hunter as union by adhesive inflammation, is an inflammatory process, attended by the pouring out of exudation to a limited extent, which glues the edges of the wound together and eventually becomes organised and converted into a *scar*, which remains as a permanent bond of union. It is the simplest process by which a wound can unite and is not attended by the formation of pus. It is the mode of union *without suppuration*. It is this mode of union which the surgeon aims at attaining, and which in these days he usually does succeed in obtaining, when he has to deal with a recent wound, such as is made in an operation.

In order to study the process, it will be convenient to take a small clean cut wound, in which no blood-vessel of any size has been injured; for if a vessel of any magnitude has been divided, artificial means will have to be taken to arrest the hæmorrhage, and this would complicate the description of the process. The wound therefore is small and the bleeding ceases spontaneously, the edges of the wound being brought together by one of the surgical means in vogue.

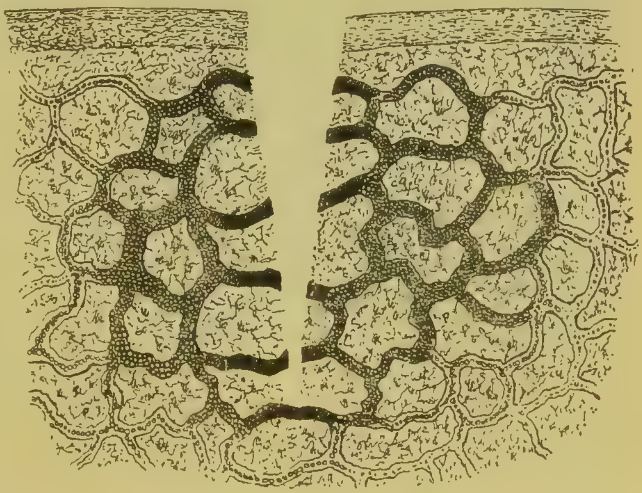

FIG. 8.—Diagram showing mode of union of wounds without suppuration. First stage: The severed vessels at the margin of the wound are filled with clot; the vessels beyond are dilated, and crowded with corpuscles.

The first point to consider is the manner in which the hæmorrhage spontaneously ceases. The blood coagulates in the vessels up to the first collateral branch given off from the injured vessel; that is, to the next point of intersection of the capillary network. The coagulation is due to several causes: in the first instance the mechanical injury which has been done to the coats of the vessel causes them to contract and so diminishes the lumen of the tube through which the blood is flowing and therefore necessarily retards the circulation; secondly, the blood which escapes from the wounded vessel is exposed to the air and brought in contact with foreign substances, that is to say, substances which are not the lining membrane of vessels, which, as we have already seen, resists the tendency, which the corpuscles possess, to adhere to anything with which they come in contact. The corpuscles therefore adhere to the tissues around the open mouth of the vessel and to the vessel itself. Some of the leucocytes disintegrate, fibrin ferment is set free, and a coagulum is formed at the orifice of the wounded vessel, and extends up the vessel to the first collateral branch derived from it, through which the blood circulates (fig. 8). Inflammation, the result of the injury which has been done, is now set up, with all its attendant phenomena. There is first of all dilatation of the vessels of the part beyond the point where they are closed by the clots which have formed ; this is followed by stasis, and then diapedesis sets in, and a rapid emigration of the leucocytes, with some red corpuscles, takes place through the walls of the vessels, attended by an abundant exudation of the watery parts of the blood. The parts around the wound are now infiltrated with inflammatory exudation, which readily finds its way to the surface of the wound by the open lymph spaces and there coagulates. The surface of the wound thus becomes covered over with a layer of transparent, glassy-like material, which is lymph. This material possesses a considerable amount of adhesiveness, and the two surfaces of the wound being covered with this adhesive material stick together with a certain degree of firmness, and the first stage in the process, 'temporary union,' is accomplished. If the injury has been momentary, and no source of irritation is present in the wound, the exudation does not last long, but soon stops, and only a thin layer of 'glaze' covers the surfaces of the wound. After coagulation has taken place, serum is expressed from the clot and escapes from the wound. The clot at first consists of small round cells—emigrated leucocytes—entangled in the meshes of the coagulated fibrin, but after a time larger cells, derived from the fixed connective tissue cells of the part, appear (fig. 9). The function of the leucocytes appears to be to remove the coagulated blood and any portions of damaged tissue which may exist; and having performed this office, they are destroyed by the larger plasma cells which now take their place. The next step in the process is the development of blood-vessels. These are formed by the budding out of pouches from the uninjured vessels in the neighbourhood, which penetrate into the plastic exudation, and coming into contact with other pouches coalesce and form a loop. From these, secondary pouches are given off, which in their turn form loops, and so on until the whole exudation is permeated with blood-vessels. The connecting medium which has now been formed consists of round plasma cells, larger than the leucocytes, between which ramify thin walled capillaries. This is called *granulation tissue*, and the final change is the conversion of this granulation tissue into fibrous or scar tissue. The round cells of the tissue elongate and become spindle-shaped, then further elongation takes place,

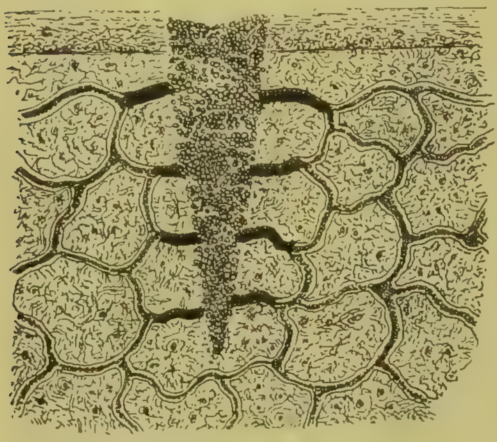

FIG. 9.—Diagram showing mode of union of wounds without suppuration. Second stage : The edges of the wound are now glued together by lymph, consisting of small round cells. The tissue on either side of the wound has been represented as normal, for the sake of clearness ; it is really also infiltrated with inflammatory exudation.

and they become converted into fibre cells, and acquire connections with the cells on either side of the cut surfaces, so that now the wound is united by a connecting medium of young fibrous tissue in which are many blood-vessels (fig. 10). As the fibrous tissue becomes more fully developed it contracts, and by its contraction obliterates many of these vessels, so that an old scar becomes much whiter and less vascular than the surrounding tissues, whereas a recent scar is redder and more vascular. At the same time that these changes are going on between the cut edges of the wound, the epithelium on the surface of the skin in the neighbourhood of the wound undergoes proliferation, and the proliferated epithelium gradually spreads over the surface of the scar tissue and thus completes the union. Scar tissue is therefore not the same thing as areolar tissue. It consists merely of white fibrous tissue, without any yellow elastic tissue, and is a new formation of a less organised material than that which it serves to unite together. Further changes may take place in scar tissue ; for it shows, within certain limits, a tendency to approximate in character to the normal tissue of the part in which it is formed. This is notably the case in bone. In cases of simple fracture, the process of union, as we shall see hereafter, is identically the same as the process of union of an open wound by first intention, with this important difference, that when the fibrous (scar) tissue is formed between the broken ends of a bone, it undergoes a further change ; lime salts are deposited in it, and it becomes converted into true bone. In many tissues, however, no such tendency to approximation is apparent ; in muscles and cartilage, for instance, there is no attempt on the part of the fibrous tissue to undergo further change into muscle or cartilage, as the case may be, but the scar remains fibrous throughout the life of the individual.

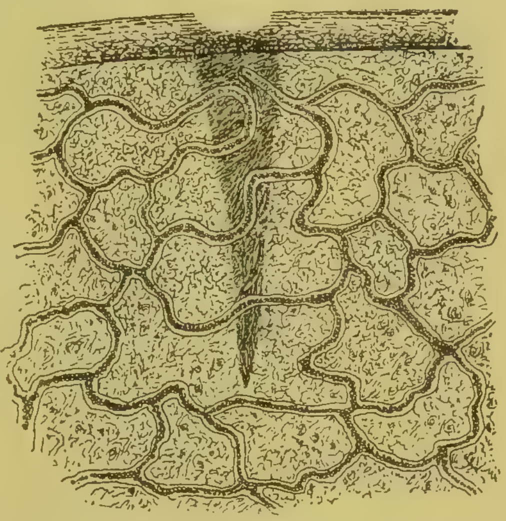

FIG. 10.—Diagram showing mode of union of wounds without suppuration. Third stage : Vessels have now permeated the connecting medium, and its cells have become converted into young fibrous tissue. Epithelium is spreading over the surface.

Union by first intention can only take place where the irritant which produced the inflammation, necessary for the purposes of repair, was momentary, and where no source of irritation or condition of unrest is present in the wound.

3. **Union by scabbing.**—This form of union scarcely merits the distinction of being placed in a separate division by itself, for it differs in no respect from union by first intention, except in the fact that the healing process goes on under a scab, which acts as a protective covering to the wound and prevents decomposition or putrefaction. It may be best studied in a wound where a portion of skin has been shaved off the body, and where therefore the edges of the skin cannot be brought together. The same changes occur as in union by first intention : hæmorrhage first ceases, then inflammation is set up ; and its attendant exudation, which is often in these cases very considerable, is poured out over the surface of the wound.

Here it coagulates, and then, losing some of its water by evaporation, dries, and so forms an occlusive dressing which covers the wound and prevents any entrance of micro-organisms from without. Underneath this dried layer of lymph, another portion in contact with the tissues beneath undergoes vascularisation and becomes converted into granulation tissue, which in its turn forms scar tissue, identically in the same manner as in union of wounds by first intention. As soon as the process is completed the scab begins to break away or separate at its margins, and as it does so the epithelium spreads in over the surface of the newly formed tissue, so that before it is completely detached a new layer of epithelium covers the surface of the wound. The main reason why union by scabbing is not oftener encouraged by the surgeon is the length of time which must elapse before the scab becomes occlusive to the entrance of micro-organisms, so that if it is attempted to bring about union in this way, it will frequently be found that suppuration takes place beneath the scab, because some micro-organisms have been admitted before the scab was formed, and thus the ends in view are defeated. Occlusion of wounds by what may be regarded in some respects as an artificial scab is sometimes resorted to by the surgeon, as in covering a wound with collodion, or a piece of dry lint, into which the blood oozing from the wound penetrates and there coagulates, forming a scab. The plan is not, however, one to be recommended except in very small wounds, because the scab is very likely not to be complete over the whole wound, but is likely to leave some small opening by which micro-organisms may find an entrance.

From what has been said as to these three modes of union of wounds, it is obvious that they are only modifications of the same process and that identically the same mode of formation of the connecting medium or scar takes place in all. They might therefore all be classed together under one head, as instances of union of wounds without suppuration.

4. **Union by second intention or by granulation.**—As I have already stated, the difference between the union of wounds by first and second intention is one rather of degree than of kind, and in both the changes which take place are very similar. In the union of wounds by granulation these changes are carried on to a further degree than in the other mode of union, and this is due to the fact that there is a longer continuance of the inflammation which is set up, and this prolongation of the inflammatory process is brought about by some irritation which continues to act for an appreciable length of time after the injury. It may be, and most frequently is, the presence of pyogenic micro-organisms, but it may also be the irritation of dressings, or chemical substances applied to the wound, especially where there has been loss of tissue, so that the edges of the wound cannot be brought in apposition ; or it may be due to the presence of dead tissue in the wound, which has first to be got rid of, before union can take place, as in contused and lacerated wounds, burns and scalds, &c. It will be most convenient to consider this mode of union in a gaping wound, that is to say, one in which the edges have not been brought together. In such a case the initial changes are the same as in union by first intention : the hæmorrhage first of all ceases and the blood coagulates in the cut vessels up to the first collateral branch : then inflammation is set up as the result of the injury and exudation takes place over the surface of the wound : but now other causes come into play, and in consequence of the presence of pyogenic organisms the inflammation, instead of subsiding and disappearing as it did in union by first intention, is prolonged, and

exudation of inflammatory products goes on until the surface of the wound becomes covered with a very thick layer of inflammatory exudation. Owing to the fact that the superficial part of this layer is far removed from any source of nutritive supply, it undergoes degeneration from malnutrition and becomes converted into pus, which escapes from the surface of the wound; but the deeper part, being nearer the source of nutritive supply, undergoes a developmental process and becomes converted into granulations. If the surface of a wound at this stage is examined, little red points will be seen studding it; these increase and coalesce till the whole of the wound may be seen to present a red, velvety appearance from the formation of a number of papillary looking bodies, which are known as *granulations*. These resemble embryonic tissue in their power of growth, and gradually increase in size and number until they fill up the space left by the gaping wound. The manner in which these granulations are formed is by the growing upwards into the deeper layers of the inflammatory exudation of little buds from the blood-vessels in the tissue beneath, exactly in the same manner as occurred in the vascularisation of the lymph, in union by first intention. These buds form loops, and wherever a loop is formed it pushes the exudation before it, so that it forms a little hillock or pyramid, consisting of a capillary loop, surrounded by a mass of round cells—the original plasma cells of the exudation material (fig. 11). These granulations gradually fill up the wound, and as the deeper parts become protected from irritation by the more superficial granulations, they undergo a conversion into fibrous or scar tissue by the same process as that already described in union by the first intention. As soon as this new fibrous tissue has formed it begins to contract and narrows the wound, so that by the time the whole of the granulations which fill the wound have become converted into fibrous tissue, the scar tissue, which now closes it, is considerably smaller than the size of the original wound; and, contraction still going on for some considerable time after the healing process is completed, a large gaping wound, or a wound where there has been

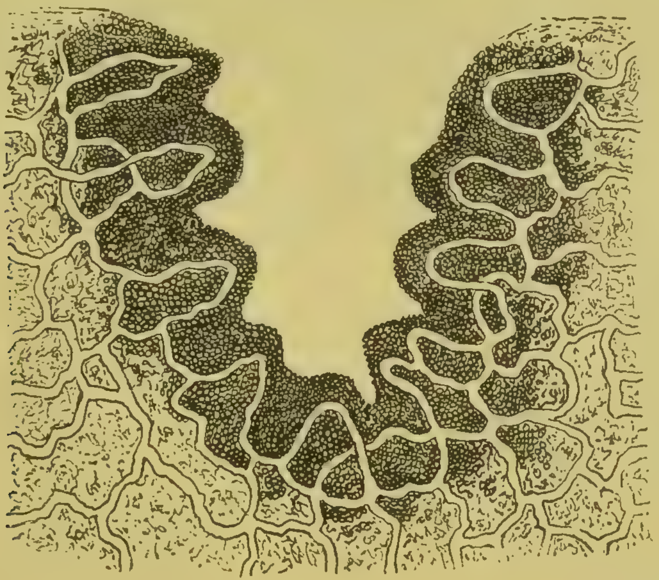

FIG. 11.—Diagram showing mode of union of wounds with suppuration.

considerable destruction of tissue, is represented by nothing more than a linear cicatrix. The final stage of the process consists in the covering over of the surface of the newly formed tissue by epithelium, which spreads over the surface from the margins of the wound.

5. **Union by Secondary Adhesion, or growing of two granulating surfaces together.**—This is another way in which union takes place with suppuration. It sometimes happens that in consequence of the edges of a wound not having been brought into apposition, or from their having become separated from each other, no union takes place between them, but their surfaces become covered with granulations. Such a condition may sometimes be seen in a case of hare-lip, where union by first intention has failed and where the edges of the wound gape and eventually granulate. If these granulating surfaces are placed in apposition and retained there, supposing the granulations are perfectly healthy, they may unite without further suppuration, the cells of the granulations become converted into fibrous tissue, and become joined together to form the bond of union. The advantage of this mode of union is that the process is completed in a shorter time than if union were allowed to take place by granulations gradually filling up the wound from the bottom, and also that the resulting scar is smaller. But it is not a mode of union which the surgeon often attempts to bring about, on account of the difficulty that there is in bringing the whole of the two granulating surfaces in immediate apposition, so that sometimes the more superficial parts of the wound are united in this way, while the deeper parts are not, and the formation of pus in these parts still goes on, without the means of escaping from the wound. Formerly this mode of promoting the union of wounds was much resorted to, especially on the Continent, where wounds, such as those made in amputations, were stuffed with charpie until the surfaces of the flaps were covered with granulations, and then they were brought into apposition by plaisters and bandages.

Healing by blood clot.—Allusion has been made to another mode in which union of wounds may take place, namely, by blood clot. This is a subject of great interest, both from a practical and pathological point of view, but the exact nature of the process has only recently been thoroughly worked out. John Hunter believed that the blood clot itself was organised, either by forming new vessels in itself, or by the protrusion of vessels into it from neighbouring structures. Subsequent investigation, however, has proved that the clot itself does not become organised, but that it acts as a pabulum and supporting structure in which a new tissue is formed, which in the case of wounds constitutes the scar tissue or cicatrix. The clot itself is got rid of by the action of leucocytes which emigrate into it, and acting as scavengers destroy it after it has done its duty as a supporting framework to the plasma cells, which also emigrate into the clot and are the active agents in the formation of the new tissue. In regard to the union of wounds, healing by blood clot generally takes place in those cases where a large cavity has been left by the removal of a tumour or such an organ as the breast. The skin is brought together, but it seldom happens that the whole of the cut surfaces are in apposition, and therefore a cavity is left, in which blood collects and coagulates, and in which union takes place by the process about to be described. Subcutaneous wounds, where there is only a small puncture in the skin, but considerable solution of continuity in the subcutaneous tissue, probably also heal in the same way, and of course the same mode of union may occur in a wound which is left gaping and in which blood collects, provided that it is kept aseptic.

The mode of union is as follows: Supposing after an operation, such as amputation of the breast, a cavity is left in which blood collects and coagulates. Inflammation is set up in the injured tissues, lymph is poured out and collects on the surface of the wound, as in union by first intention, and we have therefore a layer of lymph separating the clot from the walls of the cavity. Into this lymph the emigrated leucocytes extend by means of their amœboid movements, and passing through the lymph enter the blood clot; they now proceed to exercise their peculiar function and destroy the red corpuscles and probably also the leucocytes which have been entangled in the formation of the clot; so that in a short time all colour has disappeared from it. The leucocytes having now accomplished their allotted duty, an emigration takes place into the remains of the clot of large plasma cells derived from the connective tissue cells of adjacent parts. These in their turn destroy the leucocytes and the rest of the clot, and then undergo a process of development, becoming elongated, spindle-shaped and eventually converted into fibrous tissue; so that now the clot of blood is replaced by a mass of scar tissue, the cells of which become connected with the cells of the wall of the cavity in which it is contained, and thus union is completed. In the case of a gaping wound, epithelium grows over this new tissue, exactly in the same manner as we have seen it do in union by first or second intention.

Scar tissue.—The material which unites the surfaces of a wound together is called *scar tissue* or a *cicatrix*. It is merely a form of fibrous connective tissue. It contains no yellow elastic fibres and is denser than ordinary connective tissue. In fact it is a tissue of less highly organised form than that which it has replaced. As Rindfleisch says: 'It is far from being a connective tissue of ideally high quality.' It does not possess any of the characteristic structures of the skin, such as hairs, sweat or sebaceous glands or papillæ. It contains no lymphatics, at all events there are none in recent cicatrices; and very few, if any, nerve fibres. Old scars also contain very few blood-vessels. The vessels are numerous in recently formed scar tissue, but they soon become obliterated owing to its contraction, and the scar becomes dense, hard and white. Owing to the small degree of vascularity which scar tissue possesses, it is very prone to undergo degenerative processes.

INCISED WOUNDS

An **incised** wound may be defined as a clean-cut wound usually made by a sharp-edged instrument either by accident or in an operation. It must be borne in mind, however, that occasionally an incised wound may be made by a blunt instrument, especially in the skin over a subcutaneous bone; for example, a blow on the head from a life preserver, or a kick on the shin from a heavy boot, may produce a clean-cut wound, which possesses all the characteristics of an incised wound.

The **symptoms** of a wound are three: (1) separation of the edges; (2) hæmorrhage; (3) pain.

1. **Separation of the edges.**—The amount of gaping in an incised wound is generally considerable, more than in a contused and lacerated one of similar extent. It varies, however, very greatly in different

cases, depending upon the amount of tension, the direction of the wound and the tissues divided. All wounds which are made into parts which are in a state of tension gape widely; thus the edges of an incision made into a limb which is the seat of diffuse cellulitis will be noticed to become widely separated on account of the tension to which the skin is subjected from the effusion beneath. Transverse wounds gape much more widely than longitudinal ones. The more elastic a tissue is, the more it retracts. Thus skin, which is a very elastic structure, retracts very much, whereas fibrous tissue, which is inelastic, retracts but little. Again, the vital contractility of muscles has an important influence in the amount of separation of the edges of a wound; when a muscle is cut across, its severed surfaces separate widely from each other.

2. **Hæmorrhage.**—The bleeding which occurs in an incised wound depends principally upon the size and number of the vessels wounded, but is always greater than in a contused and lacerated wound of similar size and position; this is due to the fact that the vessels are cleanly cut instead of being torn, and therefore there is less tendency for clots to form in the open mouths of the vessels, as will be explained when speaking on the subject of hæmorrhage.

3. **Pain.**—The pain of an incised wound is of a burning, smarting character, and varies in its degree according to its position and the tissues divided. Some parts of the body, as, for example, the hands and the face, are much more sensitive than others, and the pain of wounds inflicted in these situations is much greater than in wounds of the back or buttock. Then again some patients are much more sensitive to pain than others, and suffer or appear to suffer much more acutely after the infliction of a wound. In addition, the influence of the mind or the condition of the patient at the time of the receipt of the injury has an important influence on the amount of pain felt. A wound inflicted in the excitement of a battle, or on a man in a state of drunkenness, is sometimes unfelt.

Treatment of incised wounds.—In the treatment of an incised wound, whether inflicted by the surgeon through unbroken skin or occurring from accident, we should endeavour to obtain union by first intention or by blood clot, and prevent healing with suppuration. Where the wound is made by the surgeon the result is much more likely to be favourable, as it practically depends upon the care which he exercises; while in accidents bacteria have already entered the wound, and here the efforts of the surgeon to get rid of them may not be successful. I have said that in operations the result which is obtained practically depends upon the care which the surgeon exercises in his conduct of the case, and this is undoubtedly true; but in spite of every care and precaution, now and then it happens, I believe, to all operating surgeons that some slight error or omission of detail occurs, the result of which is failure to obtain union without suppuration, though I am bound to say that in the hands of the most careful surgeons these results occur but seldom. Still the fact remains that they do occur: quite unconsciously some slight slip or error is made, bacteria are admitted to the wound, and suppuration or something worse is the result. It seems to me, therefore, that we are not justified in telling a patient that there is absolutely no risk from a contemplated operation, since a surgeon is but human, and, as I have said, a slight error, which may be fraught with the gravest consequences to the patient, may ensue.

Our object in endeavouring to obtain union by first intention is to prevent that constitutional disturbance which occurs where the wound is not aseptic, that is to say, when it heals by granulation; and also to hasten the convalescence of the patient, and to produce a scar which is much stronger, and at the same time slighter, so that in course of time it may become almost invisible. The chance of obtaining union by the first intention depends to a considerable extent on the constitutional condition of the patient. Age is an important factor in the healing of wounds; in people past the 'prime of life' the reparative process is not carried on with so much vigour as in those who are younger. Again, any organic disease of the viscera or degenerative change in the tissues, especially of the habitually intemperate individual, is unfavourable to union by the first intention.

In endeavouring to secure union without suppuration our main object is to *limit* inflammation, so that it shall not pass beyond that condition which results in the formation of a small amount of inflammatory exudation just sufficient to glue the edges of the wound together. This is to be done in the first instance by maintaining the part in as perfect a condition of rest as is possible. The cause which has excited the inflammation, that is to say, the injury which has produced the wound, for the repair of which inflammation has been set up, is transient, and therefore the inflammation will subside rapidly unless some condition of 'unrest' is present, which serves to maintain the inflammatory process and promote its continuance. This unrest may be either mechanical or chemical. Mechanical unrest may be due to the presence of a foreign body; to tension of the part from too tight sutures; to constant movement; to dragging on the wound from the weight of the limb; to a too tight bandage; to passive congestion from the dependent position of the part interfering with the return of the venous blood, or to many other apparently minor circumstances which mechanically interfere with absolute rest of the tissues. They may appear to be trivial and scarcely worthy of notice, but the careful recognition and removal of them may make all the difference between the successful and non-successful termination of the case. The surgeon who desires a favourable mode of union to his wounds after operation must not fail to pay strict attention to these minutiæ, if he would obtain for his patient a condition of complete rest, without which a continuance of the inflammation will be maintained. The most important variety of unrest in a wound is that due to the irritation produced by the introduction into it of some chemical substance. These may be irritants introduced by the surgeon, but this ought rarely to be the case, for when a wound is aseptic, as an operation wound ought to be, it is unnecessary to inject irritating antiseptic solutions into it to destroy micro-organisms which do not exist, and therefore the only chemical irritants which we need consider are those which result from the growth of bacteria in the wound. The bacteria which act in this way, and which keep up a condition of unrest in the part, are of two different kinds; one of these is the pyogenic organisms, which promote suppuration and which belong to the order of cocci; these will be considered more in detail when we come to speak of suppuration; and the other is certain saprophytic bacteria, which act as the ferment in promoting putrefaction, and which by their growth generate certain chemical substances of an exceedingly poisonous character. These organisms are introduced from without, either by the surgeon's hands, sponges, or instruments, or grow in from the skin of the patient, or they may enter with the dust from the air, though this is not common, for, as we have already seen, they perish when dried; or they may be introduced in the water, which is a favourite habitat of some of these micro-organisms. With regard to the *saprophytic* bacteria there are two ways in which we may prevent chemical unrest. We have already seen that putrefaction can only take place when some ferment (saprophytic fungi) is brought into contact with dead animal matter. The exclusion of either of these two factors would therefore prevent the formation of any of those chemical products (ptomaines) which are so prejudicial. If we could entirely free our wounds from all dead animal matter, any number of putrefactive bacteria might be admitted without any putrefaction taking place; and again, on the other hand, if we could shield our wounds from the admission of any of these bacteria, any amount of putrescible animal matter may be allowed to remain in the wound without doing any harm. As a matter of practice, however, it is advisable to combine these twofold means of preventing putrefaction: first, by scrupulous cleanliness, by drainage, and by position, to insure the perfect removal of all putrescible animal matter; and secondly, by careful attention to dressing, and by the use of antiseptic means to exclude all organisms or destroy those which may chance to be admitted. With regard to the *pyogenic* micrococci, we must aim at preventing their entrance into the wound, by remembering the sources from which they come, and taking special care to rid these parts of them before the operation is commenced. This practically resolves itself into careful sterilisation of the patient's skin around the intended site of the operation, and of the surgeon's hands, instruments, and sponges. For I think we may practically ignore any introduction of micrococci which may exist in the dust of the air of the room. The old-fashioned plan of keeping a spray of carbolic acid solution playing over the site of the wound during the performance of the operation is now almost universally abandoned.

The patient's *skin* must be most carefully sterilised, and this duty should be undertaken, if possible, at least twelve hours before the commencement of the operation. Every surgeon no doubt has his own plan of doing this, and as long as it is efficiently done it probably does not matter what details are carried out. The plan which I usually adopt is, first of all to shave the part, if this is necessary, and then to well wash it with soft soap and carbolic acid lotion (1 in 20). This must be done very thoroughly, the site of the operation and a considerable area around being well scrubbed with a nail brush, so as to remove the surface epithelium in which these bacteria live. After this has been done, the part is well bathed with ether or turpentine to get rid of all fatty material, and then thoroughly sluiced with corrosive sublimate solution (1 in 1,000). Cyanide gauze, wrung out of carbolic lotion (1 in 40), is now applied, and is covered with a piece of waterproof material (jaconet) and kept on until the patient has been placed on the operating table and anæsthetised. The surgeon's *hands* are to be cleaned in the same way by careful scrubbing with soft soap and a brush, special attention being paid to the nails and the parts under the nails. They are to be held in a basin containing corrosive sublimate solution for four or five minutes, and without being dried the operation is proceeded with. A basin by the surgeon's side should contain some of the same solution, into which he should constantly dip his hands during the progress of his work. There can, I think, be little doubt that one of the chief sources of infection of wounds is through the surgeon's hands, and numerous investigations have been made proving the difficulty of rendering the hands perfectly aseptic. This has induced many surgeons to make use of gloves in operating. The best form of glove is one of cotton thread, which can be sterilised by steam before using. In a short operation one pair is sufficient, in longer operations two or three are needed. In any case, if a septic focus is opened the gloves should be changed for another pair, as soon as the parts have been sterilised. All *instruments* to be used during the operation should be subjected to boiling in water, to which a little carbonate of soda has been added, for at least five minutes some time (half an hour) before the commencement of the operation, and then transferred at once to a tray containing a 1 in 20 solution of carbolic acid, from which they can be taken by the surgeon as he requires them during the progress of the operation, and to which they are returned as soon as they have been used. It should be noted that in cleaning the instruments after the operation great care must be taken to thoroughly cleanse all toothed instruments, such as clip forceps, dissecting forceps and such like, by carefully brushing them so as to remove all particles of blood, greasy material, &c. Finally we have to consider the question of *sponges.* Certainly the ideal plan, and the one which I always adopt in private practice, is to use fresh sponges for every operation, but this is scarcely possible in hospital work. But at all events any sponge which has been used in a septic case should be at once destroyed. With regard to the others, they should be thoroughly cleansed in cold water, and then washed with soap and hot water to which carbonate of soda has been added, and kept in a jar containing 1 in 20 solution of carbolic acid, and not used again for a week. Some surgeons discard sponges altogether, and use pads of absorbent wool or Gamgee tissue wrung out of carbolic acid solution. But they are not so absorbent, and little particles of the wool are apt to become detached and to adhere to the surfaces of the wound.

We have now to consider the various indications for the treatment of incised wounds, and these are five in number : (1) To arrest all hæmorrhage ; (2) to cleanse the wound, and remove all foreign bodies ; (3) to adjust the edges of the wound ; (4) to insure complete mechanical rest ; (5) to guard against putrefaction and infection. All of these indications may not be required in every wound ; thus it is not always necessary to employ drainage, and in aseptic operations no cleansing or removal of foreign bodies is required. We will take, in order to illustrate the subject, a wound of considerable size which has been caused by an accident, and therefore presumably has been inflicted some time before it comes under the surgeon's care. For in a small clean-cut wound very little treatment is necessary; after all hæmorrhage has ceased and the wound has been cleansed, the application of a pad of antiseptic gauze so applied that it approximates the edges of the cut is generally all that is necessary to insure speedy union.

1. **Arrest of hæmorrhage.**—If no vessel of any size has been injured, the bleeding will cease after a time spontaneously, or its arrest may be brought about by pressure, by exposure to air, or by the application of heat or cold. The hæmorrhage ceases because clotting takes place in the ends of the divided vessels ; this clotting being induced by the exposure of the part to the air ; by the orifices of the vessels being narrowed by the contraction and retraction of their coats in consequence of the injury which has been inflicted upon them ; and by the blood flowing over a foreign surface—that is, the tissues from which the vessel has retracted—to which the leucocytes adhere and, disintegrating, set free the fibrin ferment. When any vessel of considerable size has been wounded, measures will have to be taken by the surgeon to arrest the hæmorrhage, and these means will be described in the chapter on Injuries of Blood-vessels.

2. **The cleansing of the wound and the removal of foreign bodies.**—All foreign bodies, such as dirt, small fragments of stone, glass, or metal, and blood clots must be carefully removed, and this must be done thoroughly, as a single fragment left behind may become a source of irritation ; and with great gentleness, so as not to unnecessarily bruise the tissues, whose vitality has already been lowered by the injury. Large pieces must be picked out with forceps ; smaller pieces and dirt washed away with a stream of antiseptic fluid. If the wound is deep and irregular, careful syringing must be employed, though there is some risk, if the external wound is small, of forcing the antiseptic fluid into the interstices of the tissues beyond the wound and exciting irritation ; it must be done therefore with the greatest gentleness. It is better to avoid, as far as possible, the use of sponges or other material to rub the surface of the wound, as they tend to displace the clots which have formed in the cut vessels and cause a renewal of the hæmorrhage. Sponges may also prove a source of contamination to the wound unless great care is taken.

3. **Adjustment of the edges of the wound.**—A wound must be adjusted so as to bring the whole of the surfaces into apposition as far as possible, and leave no cavity in the deeper parts in which serum or blood may collect. This is sometimes a matter of considerable difficulty in large wounds left after the removal of tumours, or an organ like the breast ; but the application of a carefully adjusted bandage will generally be sufficient to maintain the surfaces in apposition. Sometimes, especially in deep wounds where muscles have been cut across, buried sutures, to which allusion will be made directly, will have to be employed. The edges of the wound must be carefully placed in apposition and maintained there. This is almost always done by sutures ; but other means, such as adhesive strapping and bandages, are occasionally employed. The principal use of these agents is, however, to support the tissues around the wound and so maintain rest, or to keep the edges of the wound in apposition after failure of union by first intention has taken place.

Sutures.—The different varieties of suture, as regards the structure of which they are composed, are numerous. They may consist of horsehair, silkworm gut, silk, silver wire or catgut, and all possess certain advantages and disadvantages, and are differently employed in different cases. In my opinion horsehair is the best material for suture, where it can be used ; it does not absorb any moisture, and may be retained any length of time ; it is pliant and slightly yielding, so that it is not so likely to cut its way through the tissues, and it is easy to manipulate ; the great objection to its use is that it is brittle, but this difficulty may be obviated to a great extent by using it double and by carefully selecting the material, as some horsehair is much stronger than others. Silkworm gut is also an admirable material for sutures ; it is non-absorbent and non-absorbable and possesses more strength than horsehair, but it is not pliant, is difficult to manipulate, and the knot is liable to slip. Silk is in my opinion not so good a material for suture, though probably it is the most universally employed of all ; it is easy to manipulate and strong, and if sterilised, which can be easily done by boiling and then immersing in carbolic acid solution, it is not irritating ; but it is very absorbable, and if suppuration occurs, it rapidly becomes saturated with the discharge and becomes a source of irritation ; it is also yielding, and unless tied too tightly is apt to give too much. Silver wire, formerly much employed, is now only used very occasionally. It does not imbibe moisture and is non-irritating, but it is not supple or easy to manage, and it is painful to remove. It is principally used in wounds of mucous surfaces or where strict antiseptic measures cannot be employed. Catgut is not a good material for sutures on the surface of the body, because it may become absorbed and give way before the wound has united, but in buried sutures it is the best material to use, as the object of the surgeon is to obtain absorption of the suture. Catgut which has been chromicised resists absorption much longer, and is extensively used by some surgeons as a suture.

The modes of applying sutures are as follows:

a. The **continuous suture** (fig. 12, B and C) is now much more commonly employed than it was a few years ago. It possesses two distinct advantages over the other common form of suture, the interrupted. First, it produces a more accurate adjustment of the edges of the wound; and secondly, it can be inserted very much more quickly. By some surgeons the more accurate and closer adjustment of the edges of a wound is not regarded as an unmixed advantage; because, they say, by uniting the wound only at certain equidistant points, and leaving the edges of the wound between them in contact, but not closely adjusted to each other, the serum, which always exudes from the clots which have formed in the cut ends of vessels and elsewhere, has a way by which it can escape. There may be some truth in this, but a means of escape for serum can always be afforded by draining the wound, and I am always more inclined to use a drainage tube for twenty-four or forty-eight hours in wounds which I unite by a continuous suture than in those in which I use an interrupted suture. There are two ways of applying a continuous suture: (1) by the glover's stitch, and (2) by the buttonhole stitch. The *glover's* suture is made by introducing the needle, armed with a long thread, from the skin surface on one side of the wound and through the cut surface on the other, until the whole of the edges of the wound have been brought into apposition (fig. 12, B). The first suture inserted is tied, and then the same thread is continued in and out until the whole wound is united, and the end of the thread is then knotted to the last loop. The *buttonhole* suture is inserted in the same way except that the needle is always passed *inside* the loop, after the stitch has been made; by this means the stitches are transverse to the cut, and there is practically a continuous line of thread on one side of the wound (fig. 12, C). The great objection which has been urged against the continuous suture is that a single loop cannot be interfered with without loosening the connections of the whole length of the thread. But this objection is practically valueless in these days, when sutures rarely require interfering with until they are removed. And, moreover, if the buttonhole continuous suture is used, and especially if horsehair is employed, it will be found that one suture can be removed without in any way loosening the others.

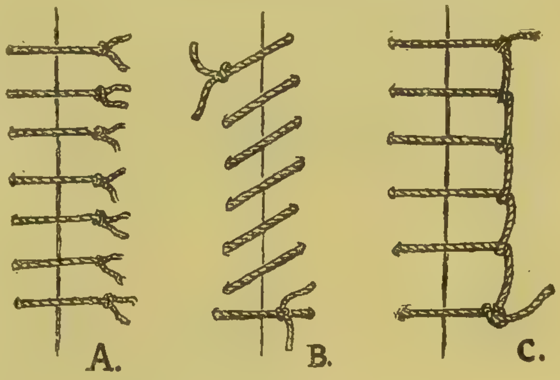

FIG. 12.—Varieties of suture: A. Interrupted suture; B. Glover's, continuous, suture; C. Buttonhole, continuous, suture.

b. The **interrupted suture** consists in introducing a single suture, tying the ends, cutting the material close to the knot, and then introducing a second, and so on until the whole length of the wound has been sutured (fig. 12, A). The main objections to this plan are the length of time it occupies in carrying out, and the less accurate adjustment of the edges which it entails.

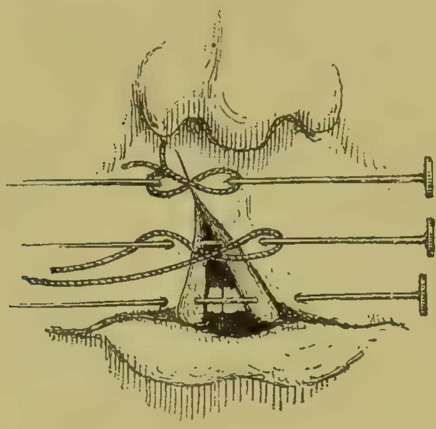
FIG. 13.—The twisted suture, as applied in a case of hare-lip.

c. The **twisted suture** is chiefly used in wounds of the lip, as in the operation for hare-lip or after removal of a portion of the lip for cancer. A steel pin is passed through the two edges of the wound, and whilst they are held in contact a piece of silk is twisted in a figure of 8 fashion under the pins and across the wound (fig. 13). In this way two, three, or more pins may be inserted. The object aimed at by this mode of suture is to diminish tension; and, in operations on the lip, to compress the divided coronary artery and to arrest the hæmorrhage from it. They should always be removed at the end of forty-eight hours.

d. The **quilled suture** is used where the deeper parts of deep wounds require to be brought into apposition. They are almost exclusively employed in the operation for ruptured perineum. For its performance a long, strongly curved needle on a handle is required. This, armed with a strong and long piece of silk, is introduced through the skin some distance from the margin of the wound and carried to its lowest level, then across

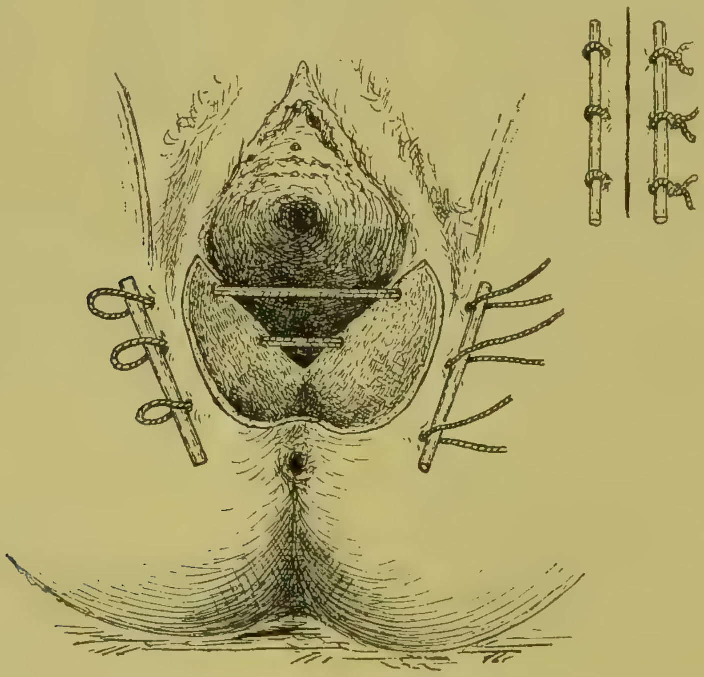
FIG. 14.—The quilled suture, as applied in a case of ruptured perineum.

it, reintroduced on the other side and brought out some distance from the margin of the wound on the opposite side. The loop of silk in the eye of the needle is now seized and the needle withdrawn. In this way as many sutures as are necessary are applied. We have now a series of loops on one side of the wound and a series of double ends at the other. A piece of a bougie is passed through the loops, and the ends tied tightly over a second piece of bougie (fig. 14). Superficial sutures will generally be found necessary in these cases in addition to the quilled sutures, as the pressure on the deep parts by the latter tends to force the cutaneous surfaces outwards.

e. **Tension sutures.**—If there is any difficulty in bringing the edges of a wound together or any tension on the stitches after they have been applied, deep 'tension' sutures should be used. A needle threaded with stout silver wire is inserted at some considerable distance from the margin of the wound, carried deeply through the tissues and brought out at a similar distance on the other side of the wound. This suture is fastened at either end to a flattened leaden button of large size, the wire being pulled as tight as possible. Several sutures may in this way be inserted, and by dragging inwards the tissues towards the wound, it allows the approximation of the edges with much less tension (fig. 15).

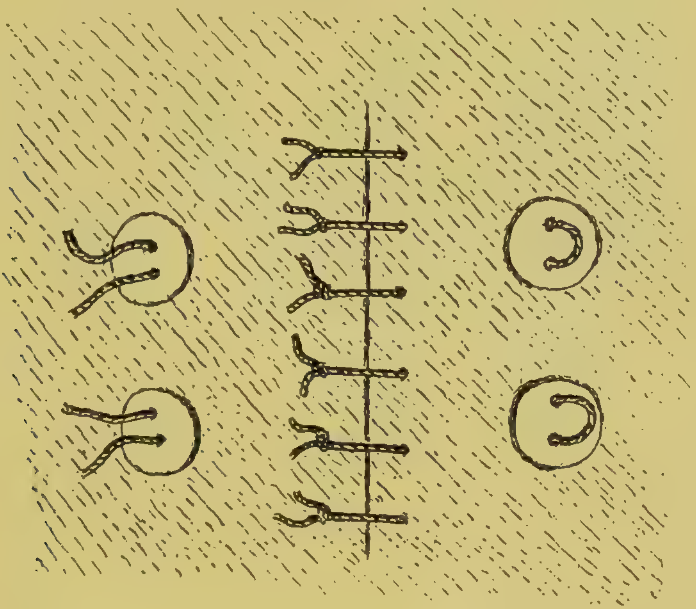

FIG. 15.—Tension sutures.

f. **Buried sutures.**—In cases where a wound is of great depth and numerous structures have been divided, it is of advantage sometimes to unite these divided tissues by 'buried' sutures. In fact sometimes this proceeding is imperatively called for, as, for instance, where nerves or tendons have been divided; but this treatment is much more widely employed by some surgeons; they stitch the deeper planes of the wound together, muscle to muscle, fascia to fascia, so as to avoid a cavity. Other surgeons, however, believe that the cavity can in many cases be sufficiently obliterated by suitably applied pressure.

4. **The maintenance of complete rest.**—Sufficient has already been said about the necessity for keeping the wound in a condition

of complete rest, both mechanical and physiological. But the point is one of so much importance that it cannot be too frequently or too urgently insisted upon. We have seen that the continuance of an inflammation in a part is in most instances due to a condition of unrest, and therefore every effort should be made by the surgeon to do away with this condition. John Hunter says: 'The first and great requisite for restoration of injured parts is rest.' Splints are frequently of use in maintaining immobility, and they should be applied so as to allow the body to rest in the easiest position possible. Pressure is also frequently of use in promoting rest by keeping parts mechanically together. A large pad of cotton wool, which from its elasticity maintains equable pressure, is often of the greatest service in securing this end.

5. **The prevention of putrefaction and infection in a wound.**—As I have already stated, there are two ways in which we may prevent the occurrence of putrefaction in a wound, either by getting rid of all dead animal matter from it, or by preventing the ingress of the ferment of putrefaction into it, for the ferment is always admitted from without and never through the circulation. It is undoubtedly true that if we could carry out either one of these two plans perfectly and thoroughly, no putrefaction could take place: if, on the one hand, we could entirely get rid of all dead matter from the wound, there would be nothing to putrefy; and, on the other hand, if we could successfully prevent the admission of any saprophytic fungi, which are the ferments of decomposition, into the wound, any amount of dead animal matter might be present, and still no putrefaction could take place.

The means which we employ to get rid of the dead animal matter is *drainage*. The chief putrescible matter of wounds is the serum of the blood; this for the most part collects in the wound during the first twenty-four or forty-eight hours after its infliction, so that it is during this time that drainage is most required. The serum is derived from the blood clots. As we have seen, blood coagulates in the open mouths of the cut vessels in order to stay the hæmorrhage, and also in other parts of the wound: after coagulation has taken place, the clots contract, and as they do so they express the serum which they contain and which if allowed to remain in the wound might be the source of decomposition; for serum under these circumstances must be regarded as dead and highly putrescible animal matter. The serum which collects in a wound during the first twenty-four or forty-eight hours may be the result of inflammatory effusion, and this is particularly likely to be so in those cases where carbolic acid lotion has been used for washing out or irrigating a wound. This antiseptic drug causes irritation to the surfaces of the wound, and a very considerable amount of serum to be exuded. We therefore employ drainage tubes in certain wounds and operations to carry away this serum. It is not in every case that drainage appears to be necessary, though until recently its importance was much insisted upon in carrying out the aseptic or antiseptic treatment of wounds. In those cases where by pressure the entire surfaces of a wound can be brought into apposition, so that no cavity remains, there is no occasion to drain, as there is no space where the serum can collect; but where a large baggy cavity is left, which cannot be subjected to pressure, as in a stump after amputation, a drainage tube is of the greatest importance. I think on the whole drainage is not practised as frequently as it should be. In my own personal experience I have more than once regretted not using a tube; I cannot say that I ever remember regretting the use of one. It seems to me that it is a wise precaution to take; it can do no harm, and the worst that can be said of it is that it necessitates the dressing of the wound on the second day, when, if no drainage tube had been used, the case would probably not have required dressing. But I am not sure that even this is an unmixed evil. I am decidedly of opinion that in many cases it adds materially to the patient's comfort to remove the soiled dressings—soiled, I mean, by the serum which has oozed into them—and readjust the bandages at the end of the first forty-eight hours. Patients always express themselves as feeling relieved and more comfortable after this first dressing. I think also it has a soothing effect on the mind. They like to be assured that everything is going on well, and this assurance carries much more weight if it is made after an actual inspection of the wound. In cases where there is any doubt about the asepticity of a wound, drainage must of course always be employed. Where, for instance, an operation has to be performed in a case where a sinus previously existed, and where therefore the surgeon cannot be perfectly sure that he has left his wound quite aseptic, a drainage tube should always be inserted.

Various kinds of drainage tubes are used in surgery. The one most commonly employed is an india-rubber tube, and those made of red rubber are the strongest and most durable. Strands of horsehair were formerly much used, and the advantage claimed for them was that they could be removed gradually, hair by hair; but this was in the days when the use of drainage was not so well understood as it is at the present day, and when the drain was allowed to remain in the wound for a much longer period. Now it is believed that this gradual withdrawal is unnecessary. Strands of antiseptic gauze form an excellent drain, especially in abdominal surgery. Long strips of gauze can be inserted between the different viscera, and the ends brought out of the external wound. A glass tube (Keith's tube) is also an exceedingly useful form of drain in abdominal surgery, for by means of this the abdomen may be well drained from in front. The drainage tube is inserted into the bottom of the pelvic cavity—the most dependent part—and the end is left protruding from the wound on the front of the abdominal wall. This is covered by a separate dressing from the rest of the wound, and this can be removed at stated intervals, and by means of a piece of india-rubber tubing attached to a syringe and passed down the glass tube, the fluid can be sucked up from the bottom of the pelvis, where it has probably gravitated. Decalcified bone was formerly recommended by Neuber for drainage, with the idea that it would be absorbed and would not require removal. It has not, however, been very generally adopted. It takes longer to absorb than is necessary, and appears occasionally to excite suppuration. In using an india-rubber tube means must be taken to prevent its slipping altogether into the wound, either by transfixing the end of it with a safety pin, which should lie across the wound, or by fixing it to one of the sutures. Care must also be taken not to leave too much protruding from the wound, otherwise it will be bent by the dressings and kinked.

The other method which the surgeon employs to prevent putrefaction or infection of a wound is to take such steps as shall prevent the introduction into it of any micro-organisms from without. This may be done by the use of certain substances which are known to destroy these living organisms, and to which the term 'antiseptics' is applied. Antiseptics are not, however, absolutely essential; any means which the surgeon can employ to prevent the admission of these germs, if employed efficiently, is sufficient to insure success, and therefore the whole treatment is better termed 'aseptic' surgery, which means that measures are taken to prevent the admission of micro-organisms, whatever those measures may be. Whereas 'antiseptic' surgery implies that certain chemical substances are employed which act as germicides and destroy any germs which may have been admitted into the wound, and also by being used as dressings prevent the entrance of germs during the healing process.

The *aseptic* treatment of wounds may be summed up in two words: *perfect cleanliness.* Everything which is brought into contact with the wound is or ought to be absolutely pure and clean, that is to say, absolutely free from micro-organisms. The air around the patient, the fluids with which the wound is washed, the instruments, the sponges, the hands of the surgeon and his assistants, the dressings which are applied, and above all the skin of the patient himself, must be subjected to such processes as shall absolutely free them from any impurities in the shape of micro-organisms. If this could be done perfectly, the system of aseptic surgery could be carried out in its entirety. But it is an exceedingly difficult if not impossible thing to bring about, and therefore it seems to me that it is fortunate that we have certain reliable chemical substances, which are known to destroy these micro-organisms; and that by their use we give an additional security to our patients. The main objection to the 'antiseptic' treatment of wounds, in contradistinction to the 'aseptic' treatment, is that the chemicals used in the former method are said to destroy not only the microbes, but also many of the tissue elements. And this is no doubt true within certain limits. As we have already stated, the application of a strong solution of carbolic acid to a wound irritates it, and so causes a very considerable amount of serum to exude, and thus produces a condition of unrest, which is not favourable to union. So that ideally the aseptic treatment is the best; the difficulty arises in carrying it out. And after all, the amount of unrest is slight, and means may be taken for making provision for the escape of the effused fluid from the wound. And moreover it is not every antiseptic which has so great an irritating property as carbolic acid.

It will be convenient in this place to mention some of the principal antiseptics in use. It will be impossible to mention all, since their number is very great and is daily increasing, and only those will be mentioned which are of proved efficacy and in common use.

Carbolic acid was the first agent employed by Lord Lister in his antiseptic system of treating wounds, and it still holds its place, and is largely employed in antiseptic surgery. It is not perhaps quite so powerful a germicide as some other antiseptics, but in some respects it stands alone. It is especially useful in the fact that it has no injurious effect upon steel instruments, and therefore is universally employed for the instruments, after they have been boiled, before an operation. The principal objection to its use in wounds is its irritant properties. When applied to the surface of a recent wound, even in the strength of 1 in 40, it increases the serous discharge for the first twenty-four hours or so, and hence renders more necessary the insertion of a drainage tube. When applied to the skin for some time, as where lint or gauze wetted with carbolic lotion is applied as a dressing, it causes very considerable irritation and often vesication. Even a surgeon in large operating practice, who habitually uses carbolic acid lotion for his hands, frequently gets very considerable irritation from its use. When applied to a raw surface, a certain amount is absorbed, and sometimes if the surface is a large one sufficient may be absorbed to produce toxic effects. The first symptom which usually shows itself is carbolurea. The urine voided is of a dark, olive-green colour. If the application of carbolic acid is at once left off, no further ill effects appear and the urine speedily recovers its natural colour; but if, on the other hand, the use of the carbolic acid is persevered with, other symptoms speedily show themselves, of which the most marked is severe and uncontrollable vomiting: the urine becomes almost black, sometimes there is a rise of temperature, with excitement and perhaps delirium; but more commonly, especially if the dose has been large, there is collapse, with a sub-normal temperature, and a rapid feeble pulse, and these symptoms may terminate in insensibility and death. Carbolic acid is used in the form of lotion, 1 in 20 to 1 in 40: in the form of oil, 1 in 5 to 1 in 20; and as gauze impregnated with carbolic acid, paraffin, and resin.

Corrosive sublimate is perhaps the most powerful and the most reliable antiseptic which we possess. Like carbolic acid, it possesses the two disadvantages of being locally irritant, though not to the same extent as carbolic acid, and of producing toxic effects, which it does in a higher degree than any other antiseptic. It enters into combination with the albumen of albuminous tissues, forming a mercuric albuminate, which is far less actively antiseptic than a watery solution; and therefore for washing out wounds it requires to be used of a much greater strength than is necessary to kill the germs when in a non-albuminous medium. The toxic effects of mercuric poisoning show themselves as pains in the abdomen, tenesmus and bloody stools, and sometimes swollen and ulcerated gums. These symptoms are especially likely to occur in patients who are the subjects of Bright's disease, so that this antiseptic should never be used in these cases. Corrosive sublimate is used in the form of a lotion, 1 in 1,000, to clean dirty wounds or foul abscesses; even 1 in 500 may be used with care, so long as every precaution is taken not to allow any of the solution to remain in the cavity, so that it cannot be absorbed in any considerable quantity. A solution of the strength of 1 in 2,000 is sufficiently strong to irrigate a wound during operation or for cleaning the surgeon's hands. Corrosive sublimate is also used in the form of gauze; but it is not to be recommended, as it produces, when wet, considerable irritation. Far better forms of mercuric gauze are the double cyanide gauze, consisting of a cyanide of mercury and zinc; and the sal-alembroth gauze, consisting of a gauze saturated with a double mercuric salt of corrosive sublimate and chloride of ammonium, formed by sublimation. The former of these two, the latest introduction of Lord Lister, is far the better, and is, I believe, more universally employed than any other dressing. A most useful form of mercuric dressing, when a dry, absorbent material is required, is 'wood wool,' made from pine wood saturated with corrosive sublimate; it is soft, elastic, highly absorbent, and antiseptic.

Salicylic acid is an excellent antiseptic, and possesses this distinct advantage, that it possesses no toxic properties. It is also non-volatile. It is, however, very irritating, especially to the mucous membrane of the nose. It is very sparingly soluble, and therefore is not used as a lotion. It is principally employed as salicylic wool, and answers admirably as a packing material. It is also used in the form of an ointment and as a dry powder, mixed with starch, as an application to the surfaces of ulcers. Both salicylic acid and corrosive sublimate are unsuitable for soaking steel instruments, as they act on the metal.

Eucalyptus oil is a powerful antiseptic and possesses no poisonous or irritating effects; but it is exceedingly volatile, and therefore is not a safe antiseptic to use, as it has been proved to lose its properties in a very few hours when maintained at the temperature of the body. It has been recommended in the form of eucalyptus gauze in cases where carbolic gauze has produced toxic effects, but it is not to be trusted. In the form of ointment it is a useful application to ulcers, and especially the ulcer of burns.

Boracic acid is a weak but useful antiseptic. It possesses no irritating properties, and can be employed in very numerous ways. On account of its non-irritant and non-toxic properties, it is useful as a lotion to wash out cavities, such as the abdomen, where large quantities of fluid are required, but in these cases it probably exerts very little more influence than sterilised water. As an ointment it is largely employed for healthy granulating wounds. In the form of boracic acid lint, it is a useful application where heat and moisture are required. This lint is made by soaking ordinary lint in a hot concentrated solution of boracic acid and then drying; immediately before using, it is again dipped in hot boracic lotion, and at once applied to the part and covered with some waterproof material.

Iodoform is a most useful antiseptic, and holds a place of its own amongst these drugs. It is especially useful in wounds opening into cavities, as in the operations for removal of the tongue, and in that for hæmorrhoids. In the former of these operations it may be credited with the result that it has almost done away with the most frequent cause of death in former days, viz. septic pneumonia from the patient inhaling the emanations from the sloughing surface of the stump; and in the latter operation it must to a great extent be credited with the fact that pyæmia, which formerly not unfrequently followed this operation, is now practically unknown. Another valuable use of iodoform is in tuberculous disease; this drug enjoys the reputation of being specially inimical to the tubercle bacillus; whether this is so or not, its use in cleaning sloughing tuberculous sores is undoubted. Iodoform possesses marked poisonous properties. The symptoms of poisoning are considerable elevation of the temperature and rapidity of the pulse, with the presence of iodine in the urine, and sometimes an erythematous eruption. In other cases there are marked brain symptoms; in some violent maniacal delirium; in others drowsiness and prostration. Iodoform very rarely causes any local irritation. It is principally used in the form of crystals, which are sprinkled over the surface of sloughing wounds, or in operations opening up cavities in which an antiseptic dressing cannot be employed. The crystal should always be used in preference to the precipitate, which is absorbed too rapidly. The chief objection to its use is the very disagreeable odour which it possesses, and which sometimes affects patients so much that they lose their appetite, complaining that everything tastes and smells of iodoform. This, however, may be corrected to a very great extent by mixing a little coumarin, the essential principle of the Tonquin bean, with the iodoform. This drug is frequently used in the form of an emulsion to inject tuberculous abscesses, e.g. psoas abscess. The emulsion is made by dissolving ten parts of crystallised iodoform in twenty parts of boiling distilled water, and then adding seventy parts of glycerine. It is also used as an ointment, and a few drops of oil of bitter almonds effectually disguises the smell. Iodoform gauze and wool are also frequently used. The former is the best form of gauze to use when it is employed as a drain.

Many other antiseptics are constantly employed by surgeons, which are too numerous to do more than mention in this work. Many of these are most powerful antiseptics, and some have their special uses. Thus **iodine** is an efficient, non-irritating antiseptic, and is especially useful in washing out foul abscess cavities. **Permanganate of potash** (Condy's fluid) is a powerful disinfectant, and has no toxic effects. It is useful as a gargle in sloughing within the cavity of the mouth. **Chloride of zinc** is chiefly useful in washing out putrefying sinuses. In solution of the strength of 40 grains to the ounce it is constantly employed to caseating tuberculous glands after they have been scraped to get rid of any particles of tuberculous tissue which have been left by the spoon. Other antiseptics in use are Creolin ; Turpentine, in the form of Terebene ; Peroxide of Hydrogen ; and Salol.

With all these antiseptic agents at our command, no doubt opinions must differ as to which is the best. My own feeling is that carbolic acid solution should be used for the instruments ; corrosive sublimate for the sponges, the hands of the surgeon and his assistant, and also for irrigation of the wound : that the most satisfactory dressing is the double cyanide gauze, which before use should be wrung out of carbolic acid lotion (1 in 40) and applied over the wound and for a very considerable area around; and that this should be covered with a thick layer of salicylic wool, which should extend considerably beyond the gauze on every side, and then that the whole should be firmly bandaged on with a considerable degree of pressure, which may be safely employed over the thick layer of wool.

CONTUSED AND LACERATED WOUNDS

Contused and lacerated wounds should be considered together, because in both, the edges of the wound are usually torn and irregular, and the tissues around infiltrated with blood, and because in both, as a rule, there is a certain amount of death of the injured tissues, varying in extent in different wounds, which must separate before the process of repair can commence. In the **contused** wound the soft parts in the neighbourhood are subcutaneously lacerated and infiltrated with blood, and the extent of this infiltration varies with the size of the missile which inflicted the injury and the force with which it was applied. This form of wound is usually inflicted with a blunt instrument, such as a life preserver; a heavy stick; a spent ball or a fragment of shell on the battle-field. In the **lacerated** wound, on the other hand, the injury is produced rather by a tearing or biting process ; lacerations by machinery, the bites of large animals or the horn of a bull act in this way, and tear more than bruise the tissues. In these wounds the edges are irregular, and the irregularity varies with the degree of elasticity of the tissues torn, and with the nature of the violence which inflicted the injury. The result produced by the varied elasticity of the tissues is well exemplified when a limb is torn off by machinery. The skin, which is very elastic, is very irregularly torn, in some parts being stripped off higher than the other structures, in others remaining as long tags, by which the limb may still remain attached to the trunk, all the other structures being torn. The tendons of the muscles are very resistant and not easily torn ; they consequently give way along their line of attachment to the muscle, and may sometimes be seen on the separated limb hanging out some inches longer than the other structures : the bellies of the muscles are torn across, at a lower level than the skin. The vessels usually project some distance from the face of the stump, for, being very elastic, they are pulled down and elongated before they give way. The internal and middle coats, being more brittle than the external one, are broken at a higher level; the outer coat is then dragged down and twisted over them, and there is therefore usually little bleeding (fig. 77). The nerves are sometimes torn off high up at their origin from the cord, and are pulled out of the wound. There is a preparation in the museum of St. George's Hospital of the limb of a little child, which was torn off at the knee joint; the whole length of the sciatic nerve may be seen attached to the stump. The bone protrudes from the end of the conical stump, being separated at a lower level than the muscles; it is often much splintered and comminuted.

The **symptoms** are the same as in incised wounds, but they differ much in detail.

(1) There is separation of the edges, but the gaping is not nearly so great as in an incised wound, firstly because the tissues around are bruised and have therefore to a great extent lost their elasticity; and secondly, on account of the lacerated nature of the wound, there are often little tags of structure stretching across from one side to the other, which have not been entirely destroyed and which serve therefore to limit the retraction which would have taken place. (2) There is hæmorrhage, but the bleeding is not so great as in incised wounds, in fact the main artery of a limb may be torn across without much loss of blood; this is due, as I have already stated, to the external coat being dragged down and twisted over the others so as to completely occlude the torn end of the vessel. In the same way the smaller vessels in a wound of less degree are dragged down and twisted before they are torn through, and this together with coagulation of the blood in the interstices of the jagged tissue sufficiently occludes the torn ends of the vessels, so that no great effusion of blood, as a rule, takes place. (3) There is pain, but the pain is of a dull, aching character, and is not so great as the pain of an incised wound. The nerves are bruised and their vitality to a great extent impaired in the neighbourhood of the wound, so that they are not so sensible of any external sources of irritation as when they are cut clean across.

In all cases of contused and lacerated wounds there is a certain amount of destruction of tissue. So much injury has been done that some amount of tissue in the neighbourhood of the wound has had its vitality destroyed and is no longer capable of carrying on the purposes of the animal economy. It is dead tissue and must be got rid of; therefore in this class of wounds there must be two processes going on: there must first of all be the process of separation of this dead tissue, before, secondly, the process of repair can take place. The amount of the tissue which is destroyed varies very much, depending upon the nature of the injury and the force with which it was inflicted. In some cases the amount of destruction of tissue is infinitesimal, and nothing more than can be got rid of by the emigrated leucocytes (phagocytes), and these wounds heal in the same manner as incised wounds, without suppuration. It will be seen, therefore, that no hard and fast line can be drawn between the two classes of wounds. But in most cases there is a visible amount of tissue which has been killed and which must separate by a process of sloughing before any attempt can be made to repair the injury. This process of sloughing is identically the same as that by which a mortified part is separated from the living tissues, and will be explained in the chapter on

Mortification. It must always be attended with suppuration, and therefore contused and lacerated wounds, except those border-land cases of which I have just spoken, must unite by second intention. After the dead tissue has separated, a granulating surface is left behind, which cicatrises in the way which has already been described.

Complications.—There are certain complications which attend this class of wounds. (1) *Secondary hæmorrhage.* This is due to the fact that the contusing force may have so injured a large blood-vessel, without actually causing a solution of continuity in it, that its vitality is destroyed and it dies and separates, just as the other tissues at the edges of the wound of which I have spoken. When the injured coats separate, an opening is made in the vessel, and secondary hæmorrhage is the result. (2) *Gangrene.* As we have seen, a certain amount of death of tissue takes place in all cases of contused and lacerated wounds; but in addition to this we may have gangrene from such damage to the main vessels of the part as arrests the circulation through them, and so death of the tissues which they supply. Or, we may have an acute infective gangrene, probably arising from the putrefactive changes in the extravasated blood of the bruised tissues, which rapidly spreads up the cellular planes, and speedily kills the patient, unless the part can be removed. This will be described in the sequel. (3) All forms of *infective inflammations* are peculiarly liable to attack contused and lacerated wounds. This is due to the fact that the tissues around the wound are more or less damaged and their vitality lowered, so that if any infective organism effects an entrance, it finds a suitable soil in which to grow and multiply; or in which, if we accept the doctrine of phagocytosis, the defending organisms are not in a condition to repel the invaders, which effect a lodgment in the tissues, where they grow and multiply and set up some form of infective disease, according to the nature of the organism. Thus erysipelas is more likely to attack a contused and lacerated wound, than a clean, incised wound.

Treatment.—Perhaps there is no class of cases in which more benefit may be obtained by antiseptic treatment than in the contused and lacerated wound. We have seen that in these cases certain tissues are killed and have to separate by sloughing; but if antiseptic measures are thoroughly carried out, the sloughing process is reduced to a minimum and the dead tissues separate with the smallest amount of inflammation and suppuration; whereas if they are neglected the inflammation is great, the suppuration profuse, and the febrile disturbance considerable. Great patience and labour must therefore be expended in thoroughly sterilising the wound, and this after all is not a very difficult matter, if it is recent. All foreign bodies which may be impacted or ground into the tissues must be carefully removed, and the part thoroughly scrubbed with a strong antiseptic solution: 1 in 1,000 perchloride of mercury solution, or 1 in 20 carbolic acid solution. If the external wound is small, so that all parts of the cavity cannot be reached, it must be enlarged, so that the whole injured surface can be brought under the manipulation of the surgeon. As a rule, it is not wise to remove any portion of skin, however contused and torn it may be, as it is impossible always to be sure whether the vitality has been entirely crushed out of it, and it is astonishing sometimes how tissues, which are apparently destroyed, will recover themselves.

As a general rule it is not necessary nor advisable to adapt the edges of the wound with sutures, for as the part must heal by granulation, no object is obtained by their introduction. If a flap of skin has been torn down, it may be desirable to insert one or two sutures to hold it in position, but at all events nothing like an accurate adaptation of the edges of the wound should be attempted. After the cleansing process has been thoroughly carried out, the wound may be dressed with wet gauze and mackintosh sheeting to retain the heat and moisture. It will be found, however, that in addition to this the frequent irrigation of the part with some weak antiseptic lotion, or, if it can be carried out, the immersion of the part in a weak antiseptic bath for two or three hours once or twice a day, will materially facilitate the separation of the sloughs with the smallest amount of suppuration. With regard to irrigation there is a little difficulty in maintaining the fluid at the temperature at which it should be applied, which is about 95° or 96° F., so that I always prefer the immersion when it can be carried out, and this in the upper extremity is not difficult, but in the lower extremity is not so easy, as it necessitates the limb being in a dependent position and so favours passive congestion. The irrigation or immersion should only be resorted to for two or three hours at a time, the wound in the interval being covered with wet gauze and mackintosh. As in the incised wound, so in these contused and lacerated wounds, every care must be taken by the surgeon to maintain the part in as perfect a condition of rest as possible, in order not only to promote a quicker union, but also to relieve the patient from pain. After the sloughs have separated, cicatrisation must be encouraged by the application of antiseptic ointments, of which perhaps boracic acid ointment is the best: attempts may be made to approximate the edges of the wound by bandages or strapping, or even the introduction of a few sutures for the same purpose may be thought desirable, and in this way the cicatrisation may be hastened.

PUNCTURED WOUNDS

Punctured wounds are produced by a thrust or stab with a sharp-pointed narrow instrument, and therefore their depth is much greater than their extent. They vary very much in degree, from a prick with a needle to a stab through the body with a bayonet. They are of two different kinds, which differ much in their behaviour and consequences, the one partaking of the character of an incised wound, the other of a contused and lacerated wound.

When a punctured wound is made with a clean, sharp-pointed instrument into healthy tissues, no serious consequences as a rule result, unless some deep-seated vessel has been injured, or some serous or synovial cavity has been opened; and even in these latter cases, if the wound is at once closed and no foreign substance has been introduced, no serious harm is to be anticipated. The wound behaves in all respects as a clean incised wound would do. Probably in these cases the wounds often unite, as I have already pointed out, by blood clot. We have daily experience of punctured wounds healing in this way in cases of osteotomy and tenotomy, where a wound whose depth greatly exceeds its breadth is made by the surgeon to divide a bone or tendon through healthy structures, with clean instruments.

But when a punctured wound is made with a blunt or triangular instrument, like a bayonet, it bruises the tissues through which it passes and produces a wound which partakes of the character of a contused and lacerated wound. We have seen that in this class of wounds a certain amount of tissue is killed outright, and that there must be sloughing and suppuration before repair can commence. And so it is in these cases of punctured wounds, with this serious addition, that on account of the character of the wound the inflammatory products cannot escape, as they do in an ordinary lacerated and contused wound on the surface of the body, but remain pent up in the tissues and produce deep-seated tension, which may be productive of the most serious consequences. In addition to this, punctured wounds when deep may injure blood-vessels, or open up cavities and wound the contained viscera, so that these wounds are amongst the gravest with which the surgeon has to deal.

Nothing need be said about the symptoms of these cases ; the presence of a small wound, with the history of the way it was caused, is sufficient to establish the diagnosis. The surgeon should, however, make careful inquiries into all the circumstances of the accident, the position of the patient and the manner in which the injury was inflicted, to establish the direction which the wound has taken ; the nature of the instrument which caused the wound, its shape, its sharpness, and whether it was septic or not. This latter point may sometimes be guessed at by collateral evidence ; as, for instance, supposing a butcher has accidentally stabbed himself with the knife he uses to cut up meat, the inference would be that the wound was septic. Supposing that after these inquiries it turns out that the wound was inflicted with a sharp-pointed and clean instrument, and that it has not passed in the direction of any of the serous or synovial cavities of the body, and there is little or no bleeding and no swelling of the tissues around, the wound may be at once covered with layers of antiseptic gauze and a bandage applied, and the wound may heal without any untoward symptoms. But the surgeon must watch the case closely and be prepared if any swelling comes on, or if there is any heat and pain about the part, or above all any rise of temperature, to at once open up the wound and drain it thoroughly. On the other hand, if there is any evidence that there has been contusion or laceration of the edges of the punctured wound, or that any foreign or septic matter has been introduced, it is worse than useless to adopt this plan. The wound should be washed out with some antiseptic solution by means of a syringe ; and care must be observed in doing this, so as not to force the fluid out of the wound into the cellular planes. The nozzle of the syringe must never be allowed to block up the orifice of the wound so as to prevent the return of the fluid ; if the external wound is not large enough to admit the nozzle and leave a space by the side of it, it must be enlarged. After the wound has been thoroughly syringed, a drainage tube must be inserted into its whole length and the wound dressed with antiseptic dressing. If at the end of forty-eight hours there is no rise of temperature the tube may be shortened by about one half, but not removed altogether. Its final removal must be determined by circumstances : if there is no discharge of pus from it, it may be shortened day by day and speedily got rid of ; if, on the other hand, pus discharges through it, it should not be withdrawn until the discharge of matter almost, if not quite, ceases. In cases where there is constant oozing of blood from a punctured wound, and especially if the blood is bright and arterial in character, the wound should be enlarged and the injured vessel sought for, and when found, tied if completely divided ; if only punctured, tied above and below the puncture and divided between (see Wounds of Arteries). Among punctured wounds must be classed those cases where a needle, or some such sharp, narrow body, penetrates the skin, and either breaks off, a part being left in the tissues, or else the whole of it disappears. These cases were formerly a source of great trouble to surgeons; since after its introduction the needle has a great tendency to travel to a distance in consequence of the movements of the part, and the manipulations of the patient or his friends and the surgeon's efforts to find and remove it were in vain. Nowadays, however, a photograph of the part with the Röntgen rays at once indicates its position, and there is no difficulty in cutting down and removing it.

Poisoned wounds

Poisoned wounds are those wounds where some foreign material is introduced, which acts injuriously upon the tissues, or in other words poisons them. This material may be *infective* or *non-infective.*

1. **Non-infective poisoned wounds.**—By the term non-infective poison we mean a substance which poisons the tissues locally and produces local effects, and has no power of multiplying in the living body: the amount of effect produced therefore by these poisons always bears a direct relation to the amount of poison introduced; the greater the amount, the greater will be the local mischief and also the general disturbance if there is any; just in the same way as a large dose of opium taken into the stomach produces greater effects than a small dose. Another point in which non-infective poisons differ from infective ones also arises from the fact that the former have no power of increasing in the body, whilst the latter have; and this is, that the non-infective poisons begin to show their effects at once, whilst the infective do not. There is usually a period, varying in duration according to the poison introduced, which is known as the *period of incubation*, during which the patient is apparently quite well and suffering no inconvenience. During this time the poison, which may have been introduced in the minutest quantity, is multiplying in the blood and tissues of the body, and it is not until it has reached a certain amount or standard that it begins to exert its effects. It will be seen, therefore, that in these cases the effect produced is in no way proportional to the dose.

Under the head of non-infective wounds it will be sufficient to describe the three following kinds: (*a*) some forms of dissection wounds; (*b*) stings of insects; (*c*) bites of snakes.

a. **Dissection wounds.**—Under the head of dissection wounds are included all kinds of wounds in which the poison introduced is derived from some dead animal matter, so that it includes those accidentally made on himself in post-mortem examinations by the person conducting the examination; those made by the student in dissecting; and those inflicted on themselves by cooks, butchers, fishmongers, and such like in pursuing their various avocations. But these wounds vary very much in intensity, and like poisoned wounds in general may be divided into two classes: (1) the non-infecting, and (2) the infecting wound. The first only of these classes will be considered here; the second will be described when speaking of infective poisoned wounds.

The **non-infective dissection wounds** are not nearly so dangerous as the other class. They are the result of the introduction of some poison which has been derived from the decomposition of the animal matter, and occur in those cases where the animal from whom the poison is obtained has been for some time dead. In these cases there is little risk of an infective dissection wound, for the bacteria of decomposition have destroyed and replaced any infective micro-organisms which may have been present in the corpse at the time of death. From this it follows that wounds inflicted during dissecting are rarely dangerous ; whereas a wound inflicted during the progress of a post-mortem examination where the subject has been dead only a few hours may be followed by the most disastrous consequences, more especially when the individual has died from some infective condition, such as septicæmia, pyæmia, and septic peritonitis. The results of a wound, when a non-infecting poison is introduced, depend upon a variety of circumstances : (1) The state of the general health of the person injured. If the individual is of sound constitution and in good health the wound may heal without any inconvenience, or at most he may get a little local pustule ; but if he is viscerally unsound, or if his health has been broken down by over-work and insufficient nutrition, or by dissipation, more serious consequences may follow. (2) Secondly, on the idiosyncrasy of the individual. Some people seem to be peculiarly susceptible to the influence of the virus. They can scarcely conduct a single post-mortem examination without imbibing some of the poison, and this seems to occur in some, without the infliction of a wound ; it may be that there is some slight abrasion or scratch which has not been noticed, or it may be that the poison passes through the unbroken skin. It is believed also, on very good grounds, that an individual who is engaged in conducting a considerable number of post-mortem examinations gains after a time an immunity from dissection wounds, for it is a well-recognised fact that those who are daily engaged in this kind of work rarely suffer from any inconvenience if they should accidentally prick or scratch their fingers, whilst another, who only occasionally makes a post-mortem examination, if he accidentally wounds himself, suffers some ill effects from it. (3) The size of the wound. A wound of any considerable size usually bleeds, and the blood carries away the poison ; moreover, if the wound is at all large the inconvenience of it induces the individual to resort to some means of disinfection and to abandon his work for a time ; whereas if the wound is a slight scratch, unattended with any pain or hæmorrhage, it is very likely to be disregarded, and the operator continues his work without any means being taken to disinfect the part, and evil consequences may ensue. Moreover, pre-existing abrasions, unknown or unnoticed, may be the means by which the poison is inoculated. If, then, the recipient of the poison is in a sound condition of health and the dose is not large, and if, above all, means are taken to get rid of the poison, no evil results may follow, and the wound may heal like any ordinary wound, or, at the worst, the poison merely exerts its influence on the tissues with which it is brought immediately in contact. A halo of inflammation is set up in the tissues around the puncture ; inflammatory exudation is poured out ; all the blood-vessels and lymphatics around become sealed, and thus a barrier is formed which prevents anything but the slightest local trouble.

(1) A little pustule may form at the site of inoculation, which bursts and discharges a drop or two of pus and then heals up ; or a little mass of tissue may be actually destroyed ; then, when the pustule bursts, a small core of dead cellular tissue separates in a few days and is cast off, and the little cavity left heals by granulation.

(2) In other cases, where the general health is not so good, or the patient has a greater susceptibility to the virus, the fencing-in process of inflammation does not appear to be so great, the virus finds its way into the lymphatics, and is carried by them to the nearest set of lymphatic glands. In these cases the superficial, and sometimes the deep, lymphatics

become inflamed, and the glands enlarged and tender, and sometimes they suppurate. The virus appears, however, to be arrested in the glands and does not extend beyond. These cases are often attended by sharp constitutional disturbance, perhaps ushered in by a rigor.

A still graver condition may sometimes occur in those who are broken down in health. Diffuse cellulitis may be set up in the wound and may rapidly extend up the cellular planes, accompanied by great pain, tension, and redness, with severe constitutional disturbance. As the cases occur in the debilitated and worn out, the condition is a serious one and may terminate in the death of the patient.

Treatment.—Bearing in mind the dangers which may attend a post-mortem wound, it should be a fixed rule that these examinations should never be made unless the hands are in a perfectly sound state; but inasmuch as it has been abundantly proved that inoculation may take place through the unbroken skin, it is a wise precaution to smear the hands with some suitable grease before commencing the examination. If an accidental prick or cut should occur, the part should be bound round above so as to encourage bleeding: then well washed in a 1 in 20 solution of carbolic acid, and finally sucked for some time, so as to extract all the morbid material. Gauze soaked in a solution of carbolic acid should now be applied and covered with a piece of waterproof sheeting; the arm kept quiet and all further work suspended. The treatment of inflamed absorbents and diffuse cellulitis will be described when speaking of those diseases.

Anatomical tubercle.—One other result of contact with dead animal matter must be mentioned. It is known under the name of *anatomical tubercle* or *verruca necrogenica*, and occurs on the knuckles or back of the hands of those who are habitually handling dead animal matter. It consists of a warty thickening without ulceration. There is a strong belief in some minds that this condition is tuberculous in nature, and certainly in my experience the victims of this disease have generally been of a tuberculous diathesis, and it has been stated by some that it is an actual local inoculation of the tubercle bacillus. It is a true warty growth, consisting of enlarged papillæ closely set and having a tendency to spread. The surface readily becomes excoriated, and bleeds or exudes serum, which dries and forms a scab.

Treatment.—In most cases protection of the hands, or cessation from the work causing it, is sufficient to effect a cure. If not, scraping the surface with a sharp spoon or the application of the acid nitrate of mercury to destroy the warty growth is all that is necessary.

b. **Stings of Insects.**—The stings of insects in themselves rarely produce any very serious symptoms, but it must be remembered that they may sometimes be the carriers of some specific virus. Thus flies are believed to not infrequently cause cellulitis when they have been previously in contact with putrefying animal matter: they have also been credited with bearing the virus of anthrax, hospital gangrene, and other infective diseases. The only other circumstances under which stings of insects can become dangerous is when from the multiplicity of their stings they produce a condition of collapse, or when from stinging the inside of the throat they cause such an amount of œdema as may interfere with respiration and need scarification for its relief. The sting of a wasp may be taken as an example of the usual results of such injuries. There is immediate severe burning pain in the part, followed by more or less œdematous swelling. In places where there is a quantity of loose cellular tissue, as the eyelid, this swelling is sometimes very considerable. The pain is said to be more severe when the sting and poison sac are left in the wound. Under ordinary circumstances the pain and swelling usually subside in the course of a few days, and no further untoward circumstances are experienced.

Treatment.—The only treatment which is necessary is the application of some alkaline lotion. A little weak solution of liquor ammoniæ, or sal volatile, will at once relieve the pain, and afterwards, if there is any swelling, a compress soaked in Goulard water, applied for a few hours, is all that is necessary. Where there is collapse from a multiplicity of stings, stimulants are required.

c. **Bites of Snakes.**—In this country the bites of snakes are fortunately rare. The common snakes are perfectly harmless, and as a rule the bite of the adder or viper is rarely fatal. It may produce as immediate symptoms a certain amount of collapse, with nausea and vomiting, but these symptoms usually pass off under appropriate treatment; or it may cause a sharp attack of diffuse cellulitis, which in the debilitated may prove fatal. In tropical climates the bites of venomous snakes produce the most serious and rapidly fatal consequences. When the poison is introduced into the system through a bite or puncture, symptoms of severe shock to the nervous system set in almost at once, or within a very short period of time, especially if the bite implicates a large vein. The patient is faint and the surface covered with a cold clammy sweat; there is tremor of the muscles and great depression, the individual lying in a semi-unconscious or almost insensible condition from which he can with difficulty be roused; sometimes there is delirium. There is often vomiting, loss of sight and hearing; a feeble intermittent pulse; and apparent difficulty in breathing. The temperature is subnormal. Where the bite has been inflicted by the most venomous species these symptoms increase in severity, the patient drifts into a condition of coma and dies. Should, however, the bite be inflicted by a less venomous variety the patient may survive this condition of collapse. Severe and lancinating pain is now complained of in the injured part, which swells and becomes livid. The swelling spreads; phlyctenulæ filled with sanious fluid form on its surface; and a condition resembling diffuse cellulitis of a most intense type is set up in the tissues around the wound. This is accompanied by general prostration, involuntary evacuations, and increasing depression, and the patient dies of toxæmia and exhaustion; or, on the other hand, the symptoms after a time may lessen in severity and the patient gradually recover.

Treatment.—The treatment must be local and general. The local treatment consists in the immediate application of a bandage or ligature to the limb above the wounded part, and this should be applied so tightly as to arrest the circulation and prevent, if possible, the introduction of the virus into the general circulation. As soon as this has been done, the injured parts should be thoroughly and freely excised. If the bite is on a finger probably the safest and surest method is to amputate the finger, but at all events the excision should be carried wide of the injured tissues. This is a far more effectual plan than cauterising the part, as is sometimes recommended; and a better plan, because less painful, than that of making a paste with gunpowder and then setting fire to it and allowing it to burn out the part. The permanganate of potash, if it can be obtained, should, after the excision, be freely applied to the raw surface; this is said to destroy the snake poison by oxidation. The general symptoms of collapse must be treated by stimulants, brandy, ammonia, and galvanism over the præcordial region. The patient should be kept in a state of constant enforced exercise as long as he can be induced to move, and artificial respiration should be resorted to when his breathing becomes oppressed. Holford has recommended the injection of ammonia into the veins (♏v to x of liquor ammonia and ♏x to xx of water), and states that it has been followed by the most beneficial results in bites from the brown snake of Australia. Sir Joseph Fayrer states that it is useless in the bite of the cobra of India. The hypodermic injection of strychnia appears also to have been attended with beneficial results in Australia. It is supposed to be directly antagonistic to the snake poison, and therefore must be given in large doses, 10 to 20 minims of the liquor strychniæ, and repeated if any relapse in the symptoms is observed.

The subsequent cellulitis, should the patient live long enough to develop it, must be treated on general principles by free incisions, warm fomentations, and the strength supported by milk, eggs, beef tea, soups, and stimulants frequently administered in small quantities.

2. **The infective poisoned wounds.**—The infective poisoned wounds are those wounds where the poison introduced multiplies amongst the tissues or in the blood, and in which, therefore, the effect produced is not in any way proportional to the amount of the poison inoculated. The smallest amount introduced on the point of a needle or lancet is sufficient to produce the gravest results, for after its introduction the infective micro-organisms contained in it increase and multiply during the period of incubation, and they or their products, circulating in the blood, infect the whole system. The principal forms of disease produced by infective poisoned wounds are: (*a*) Hydrophobia. (*b*) Tetanus. (*c*) Glanders and Farcy. (*d*) Anthrax. (*e*) Infective dissection wounds.

a. **Hydrophobia** is a disease which depends upon the introduction into the system of a specific poison through the medium of the saliva or oral mucus of a rabid animal. The exact nature of the virus is at present unknown; no specific organisms have been discovered, nor has the poison been up to the present time isolated. The disease occurs as the result of the inoculation of the poison through an open wound, though the slightest graze may be sufficient to receive it, but it is harmless when applied to an unbroken surface.

Rabies may attack many animals, but the dog is the one which usually conveys the poison to man. Next to these, cats and wolves are more frequently the source of the infection, and there seems good ground for believing, from the evidence of statistics, that the bites of these animals, when rabid, are more dangerous than the bite of a mad dog. Some have attempted to prove from this circumstance that the poison is more virulent in these animals than it is in the dog. But there seems to be no good ground for this assumption. A more rational explanation of the greater danger of the bite of a rabid cat or wolf is to be found in the fact that these animals always attack some exposed part of the body, such as the face or the throat, whereas a dog usually attacks the legs, which are probably covered, and therefore he bites through clothing, which wipes off the saliva from the teeth, and thus prevents its introduction into the wound. For it must be remembered that there is a very essential difference between the bite of a poisonous snake and the bite of a mad dog. In the former the poison is secreted by a gland in the temporal region and is conveyed by a duct, which either channels or grooves the fang, directly into the wound ; whereas in the mad dog the poison is contained in the saliva and oral mucus which moistens the teeth, and which may be easily wiped off in their passage through woollen clothing.

As regards the causes of rabies in the dog we know nothing definitely. But there seems a very fair amount of evidence to prove that it does not originate *ab initio* in this animal, but that it is always the result of direct inoculation from some other rabid animal. Muzzling, and especially quarantine for a prolonged period, of all animals admitted into any given country, entirely prevents the disease from occurring, and seems to be conclusive evidence that it cannot arise *ab initio.*

There can be no question of the identity of the two diseases—rabies in the animal and hydrophobia in man, as far as regards the poison which produces them, for not only will the saliva of the rabid dog when inoculated into man produce hydrophobia, but the saliva of a hydrophobic patient when inoculated into an animal will produce rabies.

Like many other poisons, the poison of hydrophobia is very uncertain in its action. Several persons may be bitten by the same rabid animal, but not all of them will develop the disease. The percentage of those bitten, who are attacked by hydrophobia, has been variously estimated. Trousseau estimated that about 50 per cent. of persons bitten by undoubtedly mad dogs took the disease, but others estimate the proportion as much lower. Ruffer estimates it, from a large collection of cases, at 15 per cent. The difficulty in obtaining exact statistics is very difficult, as many people are said to have been bitten by a mad dog, when they have only been bitten by 'a poor cur, who, having been worried into a bad temper, bites and foams at the mouth.' Of course these remarks as to the relative frequency of hydrophobia after bites from rabid animals refer only to those who are not subjected to prophylactic treatment.

The reason why so many persons who have been bitten escape hydrophobia is no doubt in a large measure due to the cause already alluded to, that they are bitten through their clothes and the poison is thus prevented from entering the wound. But this does not seem to be the whole explanation. Some persons and animals would appear to be insusceptible to the poison. Hertwig inoculated a dog nine times in three years, with virus which produced rabies in other dogs, without any effect ; and cases have been recorded of veterinary surgeons and others, who have been bitten on several occasions on some uncovered part of the body, as the hand, without developing the disease.

Period of Incubation.—One of the characteristic points which distinguishes hydrophobia from other forms of poisoned wounds is the great uncertainty as to its period of incubation. It may roughly be stated that this is usually from six weeks to four months, but numerous cases have been recorded when either, on the one hand, the duration of the period has been less than this, or, on the other, it has greatly exceeded it. Cases have been said to occur where the disease has developed within a week of the inoculation of the virus, and again, on the other hand, two years have been said to elapse before the development of the disease. Ruffer from his collection of cases shows that death took place in 97 per cent. of the fatal cases within four months of the receipt of the injury. I think, therefore, that it may be laid down as a broad rule that the period of incubation rarely exceeds four months, but that certain undoubted exceptions to this rule have been recorded.

A case of hydrophobia is mentioned in the 'Lancet' for September 17, 1892, in which the incubation period was said to be five years. The patient and his brother were both bitten in August 1887 by a mad dog. They both went to Paris and were subjected to Pasteur's treatment. The elder brother died nine weeks after the bite. The younger brother apparently remained in good health till September 1, 1892, when he was attacked with pain in his limbs and back; spasms on attempting to drink &c. He became convulsed and died after presenting all the symptoms of hydrophobia. The diagnosis of the disease was said to be confirmed by the post-mortem examination. It is not quite clear from the history of the case whether this may not have been a case of tetanus.

Symptoms.—After the bite of a rabid animal, no peculiar features are observed about the wound, which usually behaves in the ordinary way and heals readily. Sometimes there is some irritation about it, with perhaps glandular enlargement, but this, in all probability, is due to the caustics or other remedial agents which have been applied. The wound has usually quite healed, and presents no visible peculiarity when the *premonitory* symptoms are ushered in. These are both local and general. The *local* premonitory symptoms are not always present, but, when they exist, usually consist in an uneasy sensation or tingling about the wound, sometimes amounting to actual pain: the cicatrix may break down and ulcerate, and the wound recommence to discharge. Occasionally, it is said, vesications appear around the wound. The *general* symptoms are more marked and more constant. There is a general feeling of uneasiness and discomfort. The patient complains of giddiness, of alternating feelings of chilliness and heat, and there is great depression and fear of impending evil. There is moreover often considerable alteration in the temperament of the individual; he is morose and sullen, secludes himself from society, and takes little or no notice of what is going on around him. If conversed with or urged to exert himself, he is irritable and shows a great aversion to talk about his illness. The pulse is often much quickened, the respirations shallow, and there is loss of appetite or aversion to taking food. It is stated, principally on the authority of Marochetti and Xanthos, that, between the sixth and twentieth day after inoculation, vesicles or pustules of a peculiar character, which are called *lyssi*, may be found on the under surface of the tongue, especially around the frænum; and it has been recommended that the patient's mouth should be examined twice a day during this period, and if lyssi are found, to lay them open and cauterise them. Marochetti states that there is a tradition in Russia and Greece that if this is done, all manifestations of hydrophobia are prevented, and furthermore that he has tried the plan with success.

After these premonitory symptoms have lasted two or three days, special symptoms of the disease supervene. The most characteristic of these is a violent and repeated spasmodic contraction of the muscles, especially those of respiration and deglutition. This spasm is of a reflex character, and is induced by various slight external causes, such as a touch from a bystander, the slamming of a door, the sudden admission of a bright light, a blast of cold air, or by attempts to swallow, and after a time even by the sight of fluid or the sound of fluid poured from one vessel into another. These spasms come on gradually, and increase in severity. Generally the earliest sign is a slight spasmodic contraction of the diaphragm. This causes a pain in the pit of the stomach and induces the patient to catch his breath and hiccough. Then all the muscles of respiration and deglutition become involved, the thoracic and abdominal muscles become rigid during the attack, and after a time all the extraordinary muscles of respiration become involved; but there are intervals of complete relaxation between the spasms. Finally the whole muscular system may become implicated. During the attacks respiration may be entirely suspended for some moments, and when the muscles of the larynx become involved, death may ensue from spasm of the glottis. If the patient attempts to swallow, he will be seen to make a determined and laborious effort to do so; the cup is slowly carried to the lips and the contact of the vessel may be sufficient to induce spasm; if not, a small quantity of fluid will be taken into the mouth and an attempt made to swallow it. This is immediately followed by an intense spasmodic contraction of the muscles of deglutition, and the fluid is violently expelled: the spasm passes on to other muscles; the muscles of respiration contract and respiration is momentarily suspended; the muscles of the face become rigid, the eyes wild and staring, the nostrils dilated, the lips tense, and the whole countenance presents an expression of a mixture of terror and rage. Finally a violent convulsive seizure affects the whole body. After a time the spasms pass off, only to recur when induced by any external impression. As the disease progresses the spasms become more and more frequent, and at last seem to recur without any exciting cause. Towards the close of the case they may cease altogether, and the patient dies of exhaustion. The condition of the mind of the patient is characteristic of the disease, and early shows itself. It is a mixture of terror and distrust. There is a condition of mental agitation and ill-defined dread of the disease from which he is suffering, and with this there are often hallucinations, the patient fancying himself to be surrounded by spectral forms or horrid beasts, and, combined with these, there is a peculiar suspiciousness. He eyes his attendants with a look of distrust, and watches their every movement with suspicion. Sometimes patients become violent and maniacal, but as a rule they retain a certain amount of reason, and can be controlled by a firm and kind attendant. There is often congestion about the mouth and fauces, and considerable thick tenacious saliva and mucus clings about the lips, and is constantly being ejected by the patient. It should be borne in mind that this material contains the virus, and may be inoculated if it is brought in contact with any abrasion on the hands or other exposed surface of the surgeon or attendant. The temperature is not as a rule much raised, generally fluctuating between 100° F. and normal. The pulse is quick, weak, and often irregular; the respirations shallow and rapid. As the case progresses the strength of the patient fails, a cold, clammy sweat bedews his brow, and he dies generally in from forty-eight hours to four days from the commencement of the acute symptoms; death taking place, as we have seen, either from asphyxia, during an attack of spasm; or from exhaustion, when prior to death there may be a complete cessation of the spasmodic attacks and the mind may become perfectly clear. There are two popular fallacies with regard to hydrophobia, which it is worth while alluding to. The term hydrophobia implies a dread or fear of water, when as a matter of fact no such dread or fear exists; the patient, as a rule, cannot and will not drink. He cannot drink because any attempt to do so at once excites a reflex spasm of the muscles of deglutition, which prevents his doing so; and he will not drink because he knows that the sufferings which drinking occasions are terrible, and he will not risk setting them up; but patients who have sufficient resolution can swallow a considerable quantity of fluid and endure the contact of water in washing. The other fallacy is that patients suffering from hydrophobia 'bark like a dog.' This is nothing more or less than the loud, hiccoughing noise which is made by the spasmodic contraction of the diaphragm.

Diagnosis.—The diagnosis of hydrophobia is not generally difficult; but tetanus, occurring in one who has been bitten by a dog, has been mistaken for it. The character of the spasms is, however, different; in tetanus they are continuous, though subject to exacerbations; in hydrophobia there is complete relaxation between the convulsive attacks. Then again there are no hallucinations in tetanus, nor the same terrible anxiety: these and the absence of viscid saliva and tenacious mucus hanging about the mouth should serve to distinguish this disease from hydrophobia.

There is a form of disease which sometimes occurs in those who have been bitten by dogs, and which arises from the fear of the consequences of the bite, which is a purely hysterical condition, and is known under the names of *pseudo-* or *neuro-mimetic* hydrophobia, in which there is dysphagia, but no alarming spasm of the respiratory muscles. This condition may be recognised by careful attention to the history and symptoms, and by watching the patient for a time, when it will be found that the spasmodic contractions will cease.

Pathology.—Hydrophobia is an infective inflammation, chiefly affecting the lower part of the medulla, and implicating particularly the origins of the vagus, the hypoglossal and the glosso-pharyngeal nerves. In this situation localised areas may be seen where the perivascular spaces are infiltrated with emigrated leucocytes, and sometimes extravasations of blood, from minute vessels having given way. Intense congestion is found in the parts supplied by the above-mentioned nerves—the mouth, tongue and pharynx, the larynx and lungs, the œsophagus and stomach—and sometimes this congestion is so intense that vessels have given way and extravasations of blood have taken place. The characteristic spasm of the muscles is due to this condition of the medulla and upper part of the spinal cord, in consequence of which the slightest impulse causes a wide-spread reflex action in the muscles of respiration and deglutition.

Treatment.—Under this head we have to consider the *prophylactic* treatment; the means which should be taken to prevent the dissemination of the poison in those who have been bitten, and thus prevent the occurrence of the disease; and the *palliative* treatment which is to be adopted for those in whom the disease has been set up. First, what means can be employed to prevent the dissemination of the poison? We have already seen that, practically speaking, the disease is almost always set up by the bite of a rabid dog, and that when it occurs from the bite of any other rabid animal it is because this animal has been rendered rabid by the bite of a mad dog, and we have also seen that there is very good reason to believe that rabies never occurs *ab initio* even in the dog, but is always the result of previous inoculation. It is therefore quite clear that the prevention of rabies in the dog would effectually stamp out hydrophobia in man, and that rabies in the dog may be stamped out by attention to the three following conditions: (1) To compel the muzzling of *all* dogs for a given period of time. (2) To destroy all dogs suspected of rabies and found wandering about unmuzzled. (3) To prevent the importation of any dogs into the country without undergoing a lengthy period of quarantine.

The preventive treatment of hydrophobia in those who have been bitten by a mad dog may be general or local. The general treatment is that introduced and advocated by Pasteur, which has done so much to prevent the occurrence of this fearful disease ; for, as I have already said, the percentage of deaths from hydrophobia after the bite of a rabid animal was formerly something like 15 per cent. ; but now, by adopting the preventive treatment of Pasteur, the mortality is reduced to about one-half per cent.

Pasteur started with the idea that hydrophobia was due to the presence of a micro-organism, though this has never been demonstrated, and conceived the notion that, as is the case with many other organised ferments, these organisms in their growth produce a chemical substance which is hostile to their own development. He then, after a number of experiments, found that by simply drying portions of the nervous system of rabid animals, in which the virus is constantly present, he could progressively weaken it, until at length he rendered it quite inert, without destroying its products ; or, in other words, he destroyed the living organisms, without altering the chemical product, which was, as I have said, hostile to the development and growth of the organism. This material he first of all injected into dogs in gradually increasing doses, and found that after a time they were rendered immune to rabies. Taking now into consideration the length of the incubation period of hydrophobia, and noting that it much exceeded the period which he required to render an animal immune by his inoculations, he conceived the idea that he might prevent the development of the disease by the inoculation of this material, provided always that he could commence his proceedings within a short period of the introduction of the virus. He tried the experiment in the first instance on a boy, aged fourteen, who had been bitten in fourteen places by a mad dog, and seven years afterwards the boy was alive and well. Since this time (1886) thousands of patients have been subjected to this treatment.

For his material Pasteur uses the spinal cords of rabbits which have been rendered rabid by inoculation. These he dries by suspension over a piece of potassa fusa, in a sterilised flask maintained at a temperature of 70° F. for varying periods of time. Portions of this cord, of the required degree of attenuation, are then rubbed up in a mortar with sterilised broth, which has been rendered slightly alkaline, and injected into the flank. The injections are made once or twice a day with solutions of gradually increasing strength, that is to say, with solutions which have been subjected for a shorter and a shorter period to desiccation. Two solutions are employed : (1) for ordinary cases, of a single wound, where the treatment is begun early ; and (2) the 'intrusive,' for multiple wounds, or where the treatment has not been begun so early, and for bites of cats and wolves. In all cases the earlier the treatment is begun the better, and under no circumstances should it be delayed beyond the fourteenth day.

The *local* preventive treatment of bites of rabid animals is excision or cauterisation. A ligature should be tied tightly round the limb above the injured part so as to encourage bleeding. The tissues around the wound should then be freely excised, taking care to cut wide of the injured structures. If the bite is on a finger, it is safer to remove it. Youatt strongly recommends the application of nitrate of silver, and this is a plan of treatment which is very usually adopted: if applied at all, it must be done very thoroughly. Probably a better application is pure carbolic acid, with which the wound should be thoroughly swabbed out.

Palliative treatment.—When hydrophobia is once established, nothing hitherto tried has proved of any avail, the case always terminating in death. All, therefore, that can be done is to soothe the patient's sufferings and support his strength; this latter must be accomplished as far as possible by nutrient enemata after he has ceased to be able to swallow. Chloral, morphia given hypodermically, and inhalation of chloroform may relieve the symptoms and procure sleep. The patient should be kept free from all sources of external annoyance, in a darkened room, and surrounded by screens so as to prevent any draught of cold air reaching him.

b. **Tetanus** is defined as 'a tonic spasm of the voluntary muscles with exacerbations.' That is to say, the muscles affected are in a constant and continuous condition of contraction; but this contraction is liable to exaggerations, which come on suddenly from time to time and are marked by violent convulsive action and great pain. After a lapse of time this convulsive contraction is followed by a period of comparative rest, but very seldom by complete relaxation.

The disease belongs to the class of traumatic infective diseases in which the poison acts through the nervous system. Until within quite recent years tetanus was not regarded as an infective disease; but in the year 1884 Carle and Rattone found that, by the inoculation of the fluids expressed from the inflamed area of skin, from a patient who had died of tetanus, they could induce a similar disease in rabbits, but they also found that the blood of these rabbits who had died of tetanus when injected into other animals produced no effect. A little later in the same year Nicolaier made the discovery that earth produced tetanus when introduced subcutaneously into animals, and that this earth contained a microbe, and furthermore that pus obtained from the seat of inoculation when introduced into other animals produced a similar result. The microorganism which Nicolaier described was a rod-shaped bacillus, nearly always seen in a state of sporulation. He found it widely distributed, especially in different forms of earth. Out of 140 different varieties of earth experimented with, he was able to set up tetanus in animals in 69 cases. The year after Nicolaier published his essay on infective tetanus, Rosenbach produced tetanus by inoculating material from the seat of infection in a case of traumatic tetanus, but could not produce the disease by inoculation of the blood of the same patient. In those cases where he succeeded in producing tetanus, he found the same rod-shaped bacillus which Nicolaier had described, both in the material injected and in the area of inoculation of the infected animals. In April 1889 the tetanus bacillus was first obtained in a pure state in Koch's laboratory by Kitasato. He obtained it by making cultivations in an atmosphere of hydrogen, and then exposing them to a high temperature, which was sufficient to destroy the other organisms with which the culture was contaminated, but was not sufficiently great to destroy the spores of the tetanus bacillus.

Biologically the tetanus bacillus has two interesting characteristics. One of these is the presence of spores. It is a thin, straight bacillus, with rounded ends, in one of which a spore is developed; this is generally spherical, but may be oval in shape, and is considerably larger than the diameter of the rod in which it grows. This gives to the bacillus the peculiar club-shaped appearance which has earned for it the name of the 'drumstick' bacillus (fig. 16). This presence of a spore distinguishes it from most other forms of pathogenic micro-organisms except the bacillus of anthrax. The other characteristic of the tetanus bacillus is that it will not grow in the presence of free oxygen. It is what is termed anaërobic, and in this respect resembles the bacillus of malignant œdema and the bacillus of quarter evil in cattle. With these exceptions pathogenic microbes are capable of growing either with or without the access of air. This characteristic of the tetanus bacillus led to the difficulties of first isolating it, and it was not till Kitasato cultivated it in an atmosphere of hydrogen that he could get it to grow. Subsequently it was found that it could be cultivated in the presence of oxygen, provided grape sugar was added to the culture medium. Subsequent experiments have proved several other interesting facts in connection with this microbe. It is found that a filtered free solution of a culture will set up tetanus in an animal just as well as an ordinary culture, which is full of germs ; consequently the disease is due to the products of the bacillus, and not to the bacillus itself. A pure culture is not necessarily fatal ; but if the culture is mixed with cultures of other microbes, tetanus is invariably produced. This is no doubt due to the fact that these other microbes abstract the free oxygen, and thus prepare a condition which is favourable to the growth of anaërobic bacilli. Accordingly we find that tetanus usually occurs in wounds which are in an infective condition.

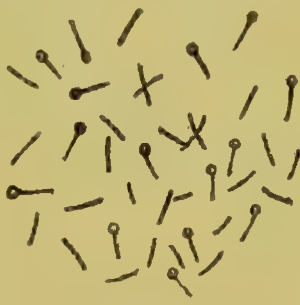

FIG. 16.—The tetanus bacillus.

From a knowledge of these facts we are enabled to explain the behaviour of these microbes. We have seen that the blood of an animal which has died of tetanus, if injected into another animal, produces no effect, and furthermore if the animal which has died of tetanus is examined, no trace of the microbe can be found in any organ or in the blood, or in fact anywhere except in the immediate neighbourhood of the focus of infection. The bacilli, when introduced into a wound, multiply, but their multiplication is limited to the seat of injection, i.e. to the immediate neighbourhood of the wound. In the dissemination of the materies morbi they take no part. This is done entirely by the products of the growth of these organisms. So that, to sum up, we may say that the tetanus bacillus, when inoculated, multiplies locally in the tissues and gives rise to certain toxic substances, which are absorbed into the blood and act like strychnine on the nervous system, especially on the medulla and upper part of the spinal cord.

Tetanus was formerly described as traumatic and idiopathic : the latter cases being those in which no abrasion or breach of the surface could be found. With our present knowledge of the infective nature of the disease, we should be inclined to believe that these so-called idiopathic cases were really cases where the wound of inoculation was not diligently sought for, or was so minute that it escaped observation. It is more than probable that every case of tetanus is traumatic in its origin. The wound is generally either a lacerated one, with recesses into which air cannot easily be admitted, and in which, therefore, the anaërobic microbe can flourish ; or else suppurating wounds, because the pyogenic organisms consume the oxygen, and therefore leave a soil favourable for the growth of the tetanus bacillus. The wound is probably in most instances contaminated with earth, since this is the favourite habitat of the bacillus. Thus we find it not uncommon in people who have fallen down and lacerated their hands against the ground. This no doubt explains the popular idea that wounds of the hand, and especially wounds of the ball of the thumb, the part most likely to be lacerated in such an accident, are liable to be followed by lockjaw. So, again, people who are run over and sustain a lacerated wound, produced by the wheel covered with mud, are frequently the subjects of tetanus, and soldiers who have been wounded and lain on the battle-field for a considerable time before they are removed to hospital are liable to become infected from the ground on which they lie. But many cases were recorded in former days, where tetanus followed operations, and it used to be taught that certain operations were more liable to be followed by tetanus than others, and of these castration was one. There can be no doubt that in these cases, the spores of the bacilli, which have great vitality and resistance to disinfectants, were often introduced into the wound on the instrument of the surgeon. Roswell Park relates the case of a surgeon who lost ten consecutive patients after operation from tetanus, in which the infection was probably introduced on a pair of forceps.

The period of incubation in tetanus is a very variable one. It is generally believed that between the fifth and fifteenth day is the most frequent period for the advent of the disease, but cases have been recorded where it has occurred within a few hours of the infliction of the wound, and others in which it has not supervened for a month. The period of incubation would appear to be influenced by two circumstances—climate and the severity of the attack. In the tropics, where it is much more common than in this country, it often appears in a very few hours after the infliction of the wound, and is rarely very long delayed. Again, in acute cases of tetanus the incubation is, as a rule, short, and a certain help to prognosis may be afforded by noticing the length of time between the infliction of the wound and the onset of the disease. Formerly it used to be the custom to divide tetanus into acute and chronic, but the division is purely artificial, and all sorts of gradations may be observed between the two conditions. This much, however, may be said, that the acute cases almost invariably die, and that the chronic cases not unfrequently recover. Formerly it used to be taught that a patient who lived beyond the twenty-first day from the onset of the attack usually recovered; this was only another way of stating the same fact, that the acute cases die and the chronic cases recover.

Symptoms.—Tetanus is a disease of the nervous system, which gives rise to tonic spasm of the voluntary muscles. Various groups are affected, with a certain degree of order. The muscles supplied by the spinal accessory, the sterno-mastoid and trapezius, with those supplied by the cervical plexus, especially the diaphragm, are very often the first to suffer. Then those supplied by the motor division of the fifth cranial nerve, the muscles of mastication, and those supplied by the seventh, the muscles of expression, become involved. The muscles of the trunk are then affected, those of the back, the abdomen and the thorax. Those of the limbs last of all become involved. Sometimes these latter escape, though as a rule those nearest the trunk are found to be in a state of tonic contraction as the disease progresses, while those more remote, the muscles of the hands and feet, are relaxed. The invasion of the disease is sometimes ushered in by a feeling of malaise. The patient complains of not feeling well, and will often volunteer the statement that he thinks he must have caught cold, as he has got a stiff neck. This is the first premonitory contraction of the muscles of the neck. He will early complain of plain in the epigastrium from spasmodic contraction of the diaphragm, and the respirations become short and catchy. The spasm now extends to the muscles of mastication and expression; the patient first of all is unable to open his mouth fully and to take any food and drink, then the jaws become clenched, and the temporal and masseter muscles become hard and rigid, and stand out in bold relief. To this condition the term *trismus* is given, and it is this which has earned for the disease its popular name of 'lockjaw.' When the muscles of expression become involved there is great distortion of the features; they become fixed and give to the countenance a ghastly grin. This appearance goes by the name of *risus sardonicus*. When the muscles of the trunk become involved, those of the back are most frequently implicated, and during their exacerbations the body is violently arched backwards, and the patient lies on the bed resting on the back of his head and his heels, with the spine raised from the bed and the belly projected upwards. To this condition the term *opisthotonos* is applied. In other cases the abdominal muscles are more at fault, and the trunk is arched forwards during the exacerbations, so that the face approaches the knees, and the back is markedly convex from above downwards. This is called *emprosthotonos*. Still more rarely the body is bent to one side, when the nerves of one side are more involved than the other. This condition, to which the name of *pleurosthotonos* is given, is one of great rarity, In some cases the trunk becomes perfectly rigid, the muscles of the abdomen retracted and hard like boards, and the chest expanded; the muscles of respiration, both ordinary and extraordinary, become contracted and rigid, and respiration is impossible. When the muscles of the extremities become implicated, the limbs are extended and the joints stiffened.

During the attacks of clonic spasm, that is to say, during the periods of exacerbation, the pain is very severe, and is similar to the pain which is complained of in severe cramp, only, of course, very much exaggerated from the number of muscles involved. During these attacks the muscles stand out prominently and feel intensely hard; the face is congested and cyanosed from defective aeration of the blood, and bedewed with a profuse sweat; the jaws are tightly clenched, the teeth ground against each other, and the face set in a ghastly grin, whilst the trunk is distorted in one of the ways indicated. These clonic spasms are, at all events in the earlier stages of the disease, of a reflex character, and like the spasms of hydrophobia are excited by some trifling irritant applied to the peripheral terminations of the sensory nerves or the nerves of the special senses. Thus they may be excited by the touch of the surgeon's or nurse's hand, by the contact of the lips with a cup or glass in an attempt to drink, or by a blast of cold air on the body; or, again, through the auditory nerve by the slamming of a door, or through the optic nerve by the sudden admission of a strong light. The medulla oblongata and spinal cord being in a state of exalted sensibility from the poison in the blood which is circulating through them, speedily reflects these slight centripetal stimuli and a violent spasm is set up. Sometimes these spasms are so severe that the muscles are ruptured. This appears to take place in the rectus abdominis oftener than in any other muscle.

The intellectual faculties are undisturbed, and in most cases the mind remains clear till the fatal termination. In some for a short time prior to death there is delirium. The pulse is quick, especially towards the end, when it beats so rapidly that it cannot be counted. This is not so much due to febrile excitement as to exhaustion from the violence of the muscular contractions; for many cases of tetanus prove fatal without any rise of temperature. It has been noticed, however, that towards the close of the case in many instances the temperature rises rapidly and to an enormous height. Instances have been recorded in which the thermometer has registered 110° F. and 112° F., and sometimes even after death it may rise one or two degrees. As the disease progresses the clonic spasms increase in frequency and severity, and appear to come on without any exciting cause. The fatal termination appears to take place sometimes from exhaustion, less frequently from suffocation during a paroxysm, and perhaps most commonly from a combination of the two causes: the patient, worn out by the severity and frequency of the tetanic spasm, dies during a convulsion. It used to be taught that death occurred in these cases from cardiac spasm, but the sudden stoppage in the heart's action which is sometimes noted is probably rather due to cardiac paralysis.

Diagnosis.—Tetanus has to be distinguished from hysteria, strychnia poisoning, epilepsy, and hydrophobia. In hysterical people there is sometimes a spasmodic condition of the muscles, especially of the jaw, producing trismus, and the muscles of the back, producing opisthotonos, which simulates tetanus. But it will be noted that there is complete relaxation at times, and the administration of an anæsthetic will usually at once clear up any doubt. In strychnia poisoning the spasms commence suddenly and culminate with great rapidity, and if the dose is not fatal they subside as rapidly. Hilton Fagge has drawn attention to the fact that the hand is clenched from spasm of its muscles, which is rarely the case in tetanus. Epilepsy is accompanied by insensibility, and between the seizures there is complete relaxation. The diagnosis from hydrophobia has already been alluded to, the spasms being clonic and not tonic.

Pathology.—The *post-mortem appearances* present nothing characteristic of the disease. The only fairly constant post-mortem change which is found is in the nerves passing from the wound. They present signs of an acute, ascending neuritis, but then the wound in most instances is obviously septic, and these changes in the nerves are not more marked than in many other forms of septic wounds, where an acute septic neuritis is set up. Formerly considerable stress was laid on this condition of the nerves, before the exact pathology of the disease had been made out. The spinal cord in some cases has been found to be congested, and Lockhart Clarke has described areas of softening, with exudation of leucocytes into the perivascular lymph spaces, and he considers that this is due to hyperæmia of the cord, accompanied by exudation and disintegration. Other pathologists have believed that the changes observed have been due rather to decomposition.

Treatment.—With regard to the *preventive* treatment of tetanus, nothing need be said except that the rigid adherence to aseptic surgery is the best means of preventing this disease. At the same time the surgeon should bear in mind the class of wound which is liable to be infected with the tetanus bacillus, namely, those into which earth has been introduced, and such wounds should receive the most rigid exploration and cleansing, especially as the bacillus, as we have already seen, shows the greatest resistance to our ordinary sterilising agents. After the disease declares itself, the wound should be opened up and thoroughly explored and cleansed. It has been recommended by some to excise the tissues surrounding the wound, with the wound itself; or when the injury is situated on an extremity, to amputate. The results, however, which have followed this practice have not proved sufficiently satisfactory to warrant its recommendation. Probably the better plan is to scrub the wound thoroughly with some strong antiseptic agent, pure carbolic acid or solution of chloride of zinc (40 grs. to the ℥ i), and then sluice it well with corrosive sublimate solution (1 in 500). Formerly division of the trunk of the nerve leading to the injured part was advocated, under the belief that the disease was due to an ascending neuritis; but though occasionally a case was recorded in which recovery took place after this proceeding had been resorted to, it is clear from our present knowledge of the pathology of the disease that the result was not due to the division of the nerve. With regard to the *constitutional* treatment of this disease, nothing could have been more unsatisfactory until the last few years. Almost every internal remedy has been successively recommended and tried, only to prove that it was perfectly useless: antiphlogistics, alteratives, diuretics, sedatives, stimulants, antispasmodics, and tonics have all been given in varying forms, and all have proved quite futile in arresting the progress of the disease. Perhaps Calabar bean is the drug which deserves physiologically the most attention. It is, as is well known, quite antagonistic to the tetanic spasms of strychnia poisoning, and it was thought that it might act similarly in tetanus, and in the hands of some it has been said to have afforded good results. It was tried in several cases at St. George's Hospital some years ago, in the form of a hypodermic injection of $\frac{1}{6}$ of a grain, frequently repeated, but without affording any marked benefit.

Professor H. de Renzi advocated what seemed to be the most rational mode of treating the disease until the introduction of the plan of injecting antitoxine. It was based on the principle of supporting the patient's strength, avoiding all sources of external irritation, and giving sedatives. The patient was placed in a room which was almost dark, with a single attendant, the door being opened every four hours to bring in and remove necessary articles and to relieve guard. The floor was thickly carpeted and all external noises rigidly excluded. The ears were plugged with wax. The patient was fed by enemata of beef tea, eggs and brandy, and chloral hydrate and bromide of potassium given in large and frequent doses.

Within the last few years a new mode of treatment has been introduced which appears to promise more encouraging results. This is by the injection of 'tetanus antitoxine,' which is supposed to be an albuminous body and would appear to be in nature somewhat similar to an enzyme. It is found in the serum of immunised animals, and the serum is used as the therapeutic agent without any further treatment such as precipitation and the like. Animals which are susceptible to the disease, e.g. horses, are injected with gradually increasing doses of a pure culture of the tetanus bacillus, until they can resist a large dose of the most virulent poison. They are then considered to be immune. The serum taken from the blood of these animals is then injected into patients who present symptoms of tetanus. Already sufficient evidence has been brought forward to prove the efficacy of this plan of treatment, and fresh cases are constantly being reported where it has been tried with a successful issue. The gravest objection against it, and no doubt the reason why it does not succeed more frequently, is that the treatment must necessarily begin so long after the poison has been inoculated; and that in acute cases death follows so rapidly upon the onset of the symptoms that there is not time for the drug to take effect. Recently it has been suggested by MM. Roux and Borrel to perform intracerebral injections of the antitoxine on the following grounds. There appears to be a very strong affinity between tetanus toxine and the cells of the brain and spinal cord; the bacteria at the seat of inoculation produce the toxine, which is absorbed and taken up by the cells of the central nervous system and fixed there. If this fixation of the toxine in the central nerve cells has taken place, the patient cannot be cured by antitoxine administered hypodermically, as the central nerve cells do not take up the antitoxine from the blood, or, at all events, are not influenced by it; but if the antitoxine is injected directly into the cerebral substance, the progress of the disease is arrested. The operation is performed by perforating the frontal bone with a drill, and introducing through this puncture a needle, with a rounded point, into the substance of the frontal lobe in front of the motor area, and on each side. Through this needle is injected $2\frac{1}{2}$ c.cm. of doubly strong antitetanic serum. This is to be done very slowly, so as to avoid breaking up the brain substance. At the same time antitoxine is injected hypodermically in the usual way. Tetanus is daily becoming more and more rare owing to the greater attention of surgeons to aseptic surgery, and I think that its treatment ought to be one rather of prevention than cure.

Trismus Neonatorum.—A form of tetanus which has been dignified by a special name requires a brief mention. This is the tetanus of new-born infants, known popularly under the name of 'nine-day fits,' because its advent is usually ushered in about the ninth day after birth. This is a true traumatic tetanus, and is due to the infection of the umbilical cord, during division, after delivery. It is very common in tropical climates, and usually runs a very acute course and terminates fatally. There is nothing, however, special about these cases to distinguish them from ordinary tetanus.

c. **Glanders** is another form of infective disease, which is due to the accidental inoculation of a specific poison, derived generally from the horse, ass, or mule. The poison is a specific organism, the *bacillus mallei*, which appears to occur primarily in the horse, and from this animal may be transmitted to man and some of the lower animals, whilst others, as oxen and pigs, are incapable of taking the disease.

The bacillus mallei is a rod-shaped organism, somewhat resembling the tubercle bacillus, but is somewhat broader, though of about the same length. It was experimentally proved fifteen years ago by Loeffler and Schütz to be the cause of glanders.

In the horse the veterinary surgeon distinguishes two diseases, *glanders* and *farcy*, which are, however, believed to be pathologically identical. Glanders in the horse is characterised by a viscid tenacious discharge from the nostrils, with ulceration of the nasal mucous membrane: accompanied by enlargement and stony hardness of the sub-maxillary lymphatic glands, which become adherent to the bone. Farcy, on the other hand, is characterised by enlargement of the lymphatic glands, especially on the inner side of the legs; the lymphatic vessels running from and to these glands also become enlarged and solid, so that they can be felt as hard, nodulated cords. The enlarged glands are known as farcy buds.

In man the two diseases are generally combined and run their course together. That is to say, there is in man both the acrid discharge from the nostril and also the presence of the farcy buds. The disease is always communicated by inoculation, generally through some slight sore or wound on the hands of those who have to do with horses. It may be communicated also by a bite from a glandered horse. It has been thought by some that there is a certain amount of evidence to show that the disease may be communicated through unbroken mucous membrane, either of the air passages or the mouth, and this probably is so.

As in other forms of infective disease, after the inoculation, there is a period of incubation before the disease declares itself. This period varies within certain limits, in different cases, according to the acuteness of the attack. These limits are two and fifteen days.

Symptoms.—The disease shows itself in two forms, acute and chronic. **Acute glanders** is ushered in, somewhat insidiously, with fever, a general sense of illness and malaise, diarrhœa and vomiting, and, it may be, a rigor. There is often aching pain in the loins and joints. The wound, if one exists, becomes inflamed and painful : the lymphatic vessels become involved, and appear as red, beaded lines running upwards from the wound to the nearest lymphatic glands, which become enlarged. This is followed by a peculiar eruption, generally before the seventh day, of hard, shotty, yellowish papules, which quickly become vesicular or pustular, and these burst and leave foul, unhealthy ulcers. This eruption attacks especially the face, chest, and abdomen. Whilst this has been going on a similar eruption has attacked the nasal mucous membrane, and a discharge from the nose sets in, at first watery, but after the pustules burst, purulent, sanious, and offensive. The nose itself becomes swollen and inflamed, and enlargement of the glands in the parotid and sub-maxillary region takes place. Numerous abscesses of a pyæmic character form in the subcutaneous tissue and in the viscera. Sometimes the eruption in the nose spreads to the pharynx and air passages and produces pneumonia ; in others it extends to the frontal sinuses, antrum, or other cavities opening into the nasal fossæ, and produces severe pain. The constitutional symptoms are of the gravest character ; great prostration and exhaustion, with low muttering delirium, vomiting and diarrhœa. As the disease progresses the symptoms resemble those of pyæmia, especially in the temperature, which is fluctuating ; in the profuse sweating ; and in the rapid wasting and failure of strength. The patient generally dies in about ten days to a fortnight, but many succumb earlier from pneumonia ; or life may be prolonged into the third week.

Chronic glanders presents exactly the same symptoms as the acute, the only difference being that they are developed more slowly. The incubation period is longer, sometimes weeks instead of days, and the eruption and subcutaneous abscesses develop more slowly. Nasal discharge is not so common in the chronic as in the acute form of the disease. These chronic cases do not invariably die, but convalescence is very slow, and the patient is left after his recovery hopelessly crippled by long-continued suppuration and sloughing.

The **diagnosis** of glanders ought not to be difficult after the appearance of the eruption, but in the early stage the febrile symptoms with pains in the joints may be mistaken for rheumatic fever ; as soon, however, as the eruption appears, all doubts ought to be set at rest. It has been said that the eruption of glanders in its early stages resembles that of smallpox, but there is little probability of mistaking the one disease for the other. In the diagnosis the history of contact with glandered horses is an important point, and therefore the recognition of the disease in horses is of the greatest importance. This can fortunately be done by what is known as the 'mallein test.' Mallein is the toxic product of the bacillus mallei, and when injected appears to have little effect on healthy tissues, but when inoculated in a glandered animal it produces the most marked reaction, with considerable constitutional disturbance. This test is therefore relied upon as a means of diagnosis of the presence of glanders in horses.

The serum diagnosis, as applied by Widal in cases of typhoid fever, has been used in glanders, and it has been found that in this disease the serum of the blood of an acutely glandered individual produces clumping of the bacilli in a very few minutes; whereas the blood of healthy persons is without any action on the bacilli. The value of the serum test is mainly applicable to the most acute cases where the mallein test is usually absent. In chronic cases it may be applied to confirm the mallein test.

Pathology.—The post-mortem appearances are merely those which are ordinarily recognised as due to blood poisoning. There are evidences of early decomposition. The blood is fluid, and the lining membranes of the head and arteries blood-stained. The spleen is diffluent. The subserous tissue of the thorax and abdomen is covered with minute extravasations of blood. Billroth considers that the presence of hæmorrhagic abscesses in the muscles is the characteristic post-mortem lesion.

Treatment.—The indications for treatment are to support the patient's strength and treat the symptoms upon ordinary surgical principles by opening abscesses early and using antiseptics freely. Internally, quinine combined with a liberal diet and free stimulation is perhaps the best line of treatment we can adopt, but strychnia, arsenic, and sulphite of sodium have been recommended. Locally iodoform is the best application, and the nostrils should be sprayed with carbolic acid or perchloride of mercury solution; or carbolic, creasote or iodine vapour inhaled.

d. **Anthrax: Malignant Pustule: Charbon.**—Anthrax is an infective disease produced by inoculation of the virus from splenic fever in animals. This disease of cattle is rare in this country, but is not uncommon on the Continent. The cases of anthrax which are met with in this country principally occur in those who are engaged in working amongst hides which have been imported from abroad. The disease is due to the inoculation of a specific micro-organism, the bacillus anthracis. This bacillus is a rod-shaped body about $\frac{1}{3000}$ to $\frac{1}{1500}$ of an inch long. It is a non-motile organism, with blunted, square-shaped ends, and sometimes presents a notched appearance in its centre, where multiplication by fission is taking place (fig. 17). It may easily be destroyed by heat or antiseptics. Outside the body, in the discharges coming from animals, or in cultures, spores may be found. These spores are exceedingly tenacious of life, and resist dry heat and many antiseptics, but iodine, bromine, and corrosive sublimate destroy their vitality. When kept dry they will remain alive and virulent for years. These spores may be introduced into the circulation by the lungs or alimentary canal, and set up a general and rapidly fatal disease, which is known by the name of 'wool-sorter's disease' (*anthracæmia*), characterised by rapid emaciation and exhaustion, associated with a low form of pneumonia.

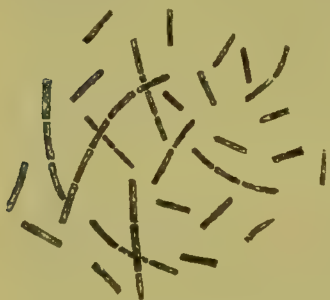

Fig. 17.—The bacillus anthracis.

Symptoms.—Anthrax is produced by the inoculation through some slight scratch or abrasion of the skin, and therefore generally occurs on some exposed part of the body, especially the hands and forearms. The wound is so small that it usually escapes detection, and the first appearance is the formation of a small pimple, which is principally characterised by the intense itching to which it gives rise. The pimple increases in size, and in the course of from twelve to fifteen hours forms a vesicle filled with yellowish fluid. The itching still continues, and the vesicle is soon burst by the patient's scratching. A dry scab now forms on the surface, at first grey, and on the second day black. The edges become indurated, and the tissues around œdematous. A second crop of vesicles now forms in the indurated tissue around the central black patch, which becomes dried and sunken below the level of the surrounding parts. The appearance is now very characteristic: a central black slough, surrounded by a ring of vesicles, and the whole supported on an inflamed and œdematous area. The process is then repeated, the secondary ring of vesicles burst, form scabs and become merged in the central black slough, while a fresh induration and ring of vesication takes place around, and in this way the eschar increases. The skin and subcutaneous tissue for some distance around become red, swollen, and œdematous, and the neighbouring lymphatic glands enlarged.

The constitutional symptoms are not severe at first; in fact, beyond a general feeling of malaise, the patient does not complain; but between the second and the fourth day, when it is supposed that the bacilli and their products have effected an entrance in considerable numbers into the blood, constitutional symptoms of a very severe character begin to show themselves. The temperature rises—102° to 104° F.—the pulse becomes quick and irregular, the skin hot and dry; there is diarrhœa, often delirium, and sometimes great dyspnœa. Towards the end the temperature falls, sometimes below normal, and there is great prostration and collapse. Death usually occurs in about a week, but cases have been recorded where the patient has recovered though no treatment has been adopted.

Pathology.—The post-mortem appearances are those indicative of blood poisoning: the blood fluid or imperfectly coagulated; the internal organs congested; the lining membrane of the heart and blood-vessels blood-stained; petechial patches on the serous surfaces, and the spleen large, soft, and diffluent. Upon microscopic examination, the blood is found to be teeming with the specific micro-organism of the disease.

Treatment.—The treatment of this disease is eminently satisfactory. It consists in a free excision of the whole indurated area, followed by the application of chloride of zinc paste or liquid carbolic acid. If the disease is recognised early and this treatment adopted, the symptoms soon subside and the patient recovers. Mr. Davies-Colley has pointed out that even in those cases where there is well-marked evidence of blood poisoning, the treatment may be followed by a successful issue. He records seventeen cases as having occurred at Guy's Hospital in ten years; of these in fifteen cases excision was performed, with thirteen recoveries.[1]

e. **Infective dissection wounds** are due to the introduction of some specific morbid poison. They generally occur when the poison is derived from a subject who has died from one of the acute infective diseases, such as erysipelas, pyæmia, or septic peritonitis. The exudations in these subjects always contain infective organisms, which are the source of the infection, and these organisms are most infective before decomposition has set in. When this takes place, the micro-organisms of putrefaction destroy and replace the infective organisms, and render the exudations inert as regards any infective properties.

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[1] *Med. Chir. Trans.* vol. lxv. 1882, p. 248.

Symptoms.—There are some cases where the local symptoms are very slight, but where there is set up a general condition which speedily carries off the patient. Within a few hours of the receipt of the injury the patient develops the most alarming symptoms of rapid prostration. He is seized with rigors and great nervous depression ; his countenance betokens the greatest anxiety, and he becomes restless, with muscular twitchings and delirium. There is failure of the heart's action, with a small, rapid pulse. A speedy rise in the temperature takes place, and there is diarrhœa and bloody stools often accompanied by vomiting, and the patient rapidly falls into an unconscious condition and dies within thirty-six or forty-eight hours from the advent of the symptoms. As regards the local signs, a pustule with an inflamed area around, with pain in the part, may be all that is noticed.

These cases are happily very rare, and are due to an acute septic intoxication due partly to the virulence of the poison and partly to the vitiated condition of health of the recipient of it. Nothing can be done in the way of treatment for these cases. The whole course of the disease is so rapid, the patient being knocked down, as it were, by an overwhelming dose of the poison, that all efforts of the surgeon are powerless to stop its course. Probably it is desirable to try the effect of the injection of anti-streptococcic serum, but at the present time we have no accurate knowledge of its results in these cases. This subject will be again alluded to in speaking of septicæmia.

In other cases, where possibly the dose of the poison may not be quite so virulent and where the patient's life is somewhat prolonged, diffuse suppuration may take place in parts of the body remote from the wound; e.g. where the wound has been inflicted on the hand, in the axilla, pectoral region and neck. When incisions are made, ill-formed pus mixed with shreddy lymph is exuded, and the patient rapidly falls into a condition of asthenia, with low muttering delirium, and usually dies in the course of a few days of exhaustion or of a low form of pneumonia. Again, there are other cases where the symptoms are still more local, and where a rapid, spreading cellulitis starts from the wound and rapidly extends up the limb, accompanied by fever and great prostration. These to a certain extent resemble the worst form of non-infective dissection wounds, where a diffuse cellulitis is set up ; but that they are true infective wounds is evidenced from the fact that they are capable of setting up erysipelas in those who are brought in contact with them and who may be unfortunately infected by them. The constitutional symptoms also are of a grave type and are accompanied with much prostration. In these cases the part rapidly swells ; the swelling, commencing at the wound, speedily involves the whole limb and is at first hard and brawny, with much pain, redness, and tension, but speedily runs on to suppuration ; in other cases it is œdematous and pale and does not rapidly suppurate : the tissues when cut into presenting a gelatinous appearance, infiltrated with serum and ill-formed pus. These latter cases are the worst type of the disease. The general symptoms are those of fever of a typhoid or asthenic type. There is a burning hot, dry skin ; a dry, furred tongue, with sordes on the gums and teeth ; a temperature ranging from 102° to 104° F. ; a weak, quick, compressible pulse ; a sensation of nausea and vomiting; diarrhœa; low muttering delirium and twitching of the muscles. The urine is scanty, high-coloured, and may contain albumen; the bowels are constipated, and if they act, the motions are offensive.

The **treatment** must be local and general. The *local* treatment must be free incisions wherever there is swelling and tension, followed by immersion in a hot boracic or corrosive sublimate bath for two or three hours once or twice a day, with hot boracic fomentations in the intervals. The *general* treatment must be stimulating, wine and brandy given in small and frequently repeated doses. Bark, and ammonia or quinine, and such fluid nourishment as the patient can take; beef tea, eggs, milk &c., are powerful adjuncts which will do much to carry the patient through his attack.

The convalescence in these cases is often very tedious, and the patient's constitution is sometimes shattered for life.

GUNSHOT WOUNDS

Under the term **gunshot wounds** we include all injuries caused by shot or other missiles discharged from fire-arms, all wounds produced by stones, splinters of wood, set in motion by a shell or bullet, and wounds caused by the bursting of a shell or fire-arm. It is customary, therefore, to divide gunshot wounds into *direct*, i.e. caused by a body which is projected by the force of the explosion itself, and *indirect*, i.e. those caused by some body set in motion by the projectile. The distinction is not, however, of any great practical importance, since all gunshot wounds, in whatever way produced, belong to the class of contused and lacerated wounds.

It will be convenient to divide what we have to say on this subject into three heads, according to the nature of the missile which produced the wound, viz. (1) bullet wounds; (2) wounds from the bursting of explosive shells; and (3) wounds from small shot. And in doing this we must necessarily be very brief, as these injuries are rare in civil practice, and those who propose to enter the army or navy will receive adequate instruction in this subject elsewhere. Only so much, therefore, will be said as is indispensable to the general surgeon.

1. **Bullet wounds.**—The character of the wounds produced by rifle bullets in the present day is very different from what it was some thirty or forty years ago, on account of the alterations which have been made in the character and shape of the bullet. At that time the only bullet used was the round leaden bullet, which varied much in weight, varying from three-quarters of an ounce to as much as an ounce and a half. This has now been superseded by the conoidal bullet, of which the latest development in the British Army is the Lee-Metford, consisting of a central core of lead and antimony, with an outside casing of copper and nickel (fig. 18). Its weight is 217 grs. and its calibre ·303 inch. Its velocity is stated to be two thousand feet per second. Its weight and size is, therefore, considerably less, and its velocity greater, than the Snider, which is composed of pure lead, or the

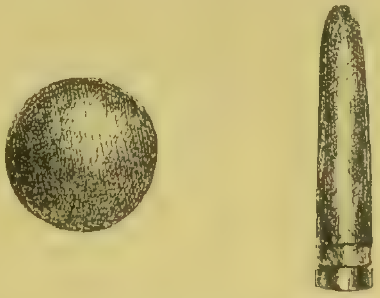

FIG. 18.—Bullets. The old round leaden bullet and the Lee-Metford bullet.

Martini-Henry, composed of lead and tin. The new bullet is characterised by its small size, its lightness, its hardness, its pointed shape, and its high velocity. The result of this is that this bullet acts as a wedge, splitting and penetrating the tissues, and in doing so leaves a narrow track, with well-defined edges, in which the tissues are thoroughly disintegrated. The old round bullet, on the other hand, in its passage through the body, contused and bruised the tissues to a much greater extent than the conoidal bullet. On this account, combined no doubt with the absence of efficient drainage and antiseptics, in former days, there was always deep-seated sloughing and suppuration; whereas the wound produced by the conoidal bullet, with good drainage and antiseptic precautions, may heal without suppuration. The round bullet quickly loses its initial velocity, and may become lodged in the tissues (fig. 19). The loss of momentum sustained by this bullet as it traversed the tissues caused the wound of exit, when there were two wounds, to be irregular and jagged, while the wound of entrance was round and generally rather smaller than the missile which had passed through it, on account of the elastic recoil of the tissues. With the conoidal bullet there is practically no difference between the two wounds. Again, the conoidal bullet being smaller and travelling with greater velocity is less likely to carry any foreign body, as the clothing, into the wound. In consequence of its hard covering of nickel and copper, it never breaks up in the wound as the old leaden one used to do. So long as the conoidal bullet meets with no bone in its course, the wound will be a simple straight one, as it cuts its way through the tissues and is not deflected. Should it strike bone, this is usually extensively splintered if it impinge against compact bone, as the shaft of the femur; if, however, it strikes soft, cancellous bone, this is usually perforated. In spite of all this the wounds produced by bullets in modern warfare are fully as destructive as those in olden times. The number of deaths from hæmorrhage is very much greater. In former days death from primary hæmorrhage did not often occur: this was because the bullet, travelling with a low rate of velocity and diminishing momentum, on striking a vessel, pushed it on one side and did not cut it through. In doing this no doubt it often bruised the coats and subsequent sloughing took place, leading to secondary hæmorrhage. The conical bullet, however, of the present day cuts its way through the vessel, and if this is one of large size, fatal hæmorrhage takes place. This is proved by the experience of the late Chilian war, where the Lee-Metford bullet was used. The proportion of dead to wounded was as 4 to 1, clearly pointing

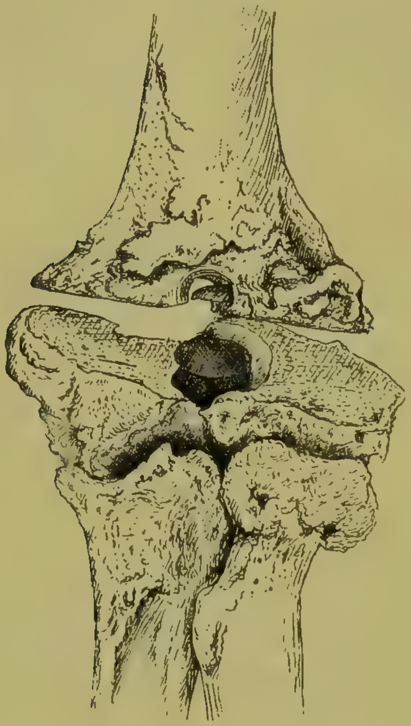

FIG. 19.—An old leaden bullet lodged in the cancellous tissue of the lower end of the humerus. The patient from whom the preparation was taken was shot in the arm twenty-two years previously, during the Peninsular War. (From the Museum of St. George's Hospital.)

to the number of deaths from hæmorrhage. Again, in modern warfare there will be more gunshot wounds, for the conoidal bullet travels with such force and velocity that it may pass through one individual and wound a second behind him. In consequence of their greater velocity and momentum bullets will not so often lodge in the tissues, and there will be fewer cases where there is only one wound, the wound of entrance, and where the bullet, being retained in the tissues, requires removal.

Symptoms.—Pain may be absent. In the excitement of battle the soldier may be unconscious that he has been wounded, or may recognise the fact only from finding blood issuing from some part of his body. On the other hand, the pain may be intense, and is especially great in those cases where the bullet is lodged under the skin, and presses upon or stretches the peripheral terminations of the sensory nerves. The pain in these cases is often greater than when a large nerve has been severed; when this is the case there may be little or no pain, but, on the other hand, the pain may be great. So, again, the pain is often worse when a bone has been shattered or a large cavity penetrated. There is less pain from the small, conical bullet, travelling with great velocity, than from the larger round bullet, which travels more slowly. Shock varies much in intensity, and is to a certain extent an index of the gravity of the case, for it is always great when one of the large cavities of the body, the abdomen or thorax, has been perforated, or where a limb has been carried away. But the intensity of the shock is also contributed to by the previous excitement of the battle-field and the fear of impending death. Shock in gunshot wounds, as in all other injuries, is always greater where a large number of peripheral nerve endings have been implicated; it is always therefore great where parts supplied with a large number of sensory nerves are involved, as the genital organs, the hand, and the foot, or where there has been a large area of superficial injury. The symptoms do not differ from those produced by other injuries. The fall of temperature is the most important sign as regards prognosis. Those cases where the temperature drops considerably below normal must always be regarded with the gravest suspicion. Syncope is often present, not only arising from loss of blood, but also in those cases where a large nerve trunk has been injured. The hæmorrhage varies in amount according to the size of the vessel or vessels wounded. If a bullet traverses a limb, as the thigh, and the main vessel escapes, the bleeding is often very trifling and was less formerly than it probably will be in the future, when vessels will be more cleanly cut across. If, however, the bullet divides the main artery of the limb, there will probably be fatal hæmorrhage, but not quite necessarily so. The bleeding may be temporarily arrested by the retraction of the inner coats of the artery and the clotting of the blood in the track of the bullet. Wounds of the main vessels in the cavities of the thorax and abdomen are almost immediately fatal.

Instantaneous rigor mortis (cataleptic rigor mortis) is occasionally observed in those who are suddenly killed from gunshot injuries, and seems to occur most frequently where the brain or spinal cord has been lacerated. Thus a case is recorded of a soldier who was shot at the moment of mounting his horse. He was instantaneously killed and remained in the same position as he was at the moment of death, with his foot in the stirrup and his left hand grasping the horse's mane. No satisfactory explanation has been given of this peculiar state.

As soon as the patient rallies the temperature begins to rise and reaction sets in; the pulse becomes stronger; the face flushes; headache is complained of or the patient may become delirious. Formerly suppuration was the almost inevitable consequence of a gunshot wound, and even in the present day healing without suppuration is comparatively rare, on account of the absence of suitable treatment in the first instance, and the insanitary conditions to which the sufferers are unavoidably exposed in the crowded hospitals in times of war. Forty-eight hours or so after the receipt of the injury the patient will be found in a state of septic traumatic fever, complaining of acute pain in the wound, the tissues around which will be found to be swollen and tense, with heat of the part and redness. These symptoms are due to the retention in the wound of putrid matter and exudation, and they speedily culminate in suppuration. The discharge is profuse and offensive, and the septic absorption which takes place from the wound is so considerable that the patient may sink into a state of profound septicæmia and die. Should he not do so, the fever generally diminishes about the tenth day; this is due to granulations having formed over the surfaces of the wound, and these form a barrier to the absorption of so great an amount of septic material. A period of great danger to the patient is while the sloughs are separating, because during this period secondary hæmorrhage is very liable to occur, more so in the olden days than at present. It may be that the bullet, in its course, has struck some vessel of importance, without actually dividing its coats. The force of the blow has been so great that the vitality of the vessel at the point struck has been destroyed, and the injured tissues must be got rid of; when they separate, perforation in the vessel takes place and secondary hæmorrhage is the result. In other cases where the vessel has been bruised without being cut, thrombosis may occur and gangrene of the limb result, especially if the vein has also been injured. And again in other cases a traumatic aneurism or an arterio-venous aneurism may be the result of the injury to the vessel walls.

Treatment.—The immediate treatment has first to be considered. The first indications for the surgeon are to combat the pain, the shock, and the hæmorrhage, if there is any. The pain, if severe, should be relieved by a hypodermic injection of morphia. The shock, if it is very great, is best overcome by the subcutaneous injection of ether (30 or 40 minims) or a solution of strychnine ($\frac{1}{30}$ of a grain). If not so severe the patient should be kept recumbent, with the head low: wrapped up as warmly as possible and some hot fluid administered; beef tea, coffee, or brandy, according to the requirements of the case. In transporting him to the field hospital the bearers should be cautioned not to raise the head, but carry it on a rather lower level than the rest of the body. With regard to the hæmorrhage, this was formerly not an important feature in the treatment of the case, but is likely to be more so in the future. Many experienced military surgeons have stated that they have never met with a case of primary hæmorrhage on the battle-field, that required a ligature. The patient was either dead before any assistance could be afforded, or else the hæmorrhage had stopped or was not formidable enough to require an immediate ligature. Should, however, bleeding occur and require treatment, it is better on the battle-field to arrest the hæmorrhage temporarily with a tourniquet and then transport the patient with all expedition to the field hospital, where it can be more efficiently dealt with. The tourniquet may be improvised by tying the soldier's scarf or handkerchief round the limb, and then introducing a bayonet or the scabbard of a sword between the bandage and the limb, and screwing it up tightly. With regard to the treatment of the wound on the field, the rule is laid down that no examination or handling of it should be made, but that it should be simply occluded temporarily with an antiseptic dressing and the patient allowed to proceed at once to the hospital, where a systematic examination can be undertaken. And if we consider that it is the universally received opinion that the bullet is aseptic at the time of its introduction, and that unless any clothing or foreign body is carried in with it, the wound is aseptic when first inflicted, we shall understand how important this rule is ; for it is clear that if the wound subsequently becomes septic this must be due mainly to the introduction of a septic finger or instrument ; and how can they be otherwise under the circumstances ? The soldier carries the first dressing with him as part of his kit. The duty of the surgeon on the field is, therefore, to rally the patient from his shock, temporarily arrest hæmorrhage, and occlude the wound provisionally, and then to place the wounded soldier on a stretcher, with the injured part in a suitable position and immobilised as far as possible, and have him transported to a place of security.

Here a thorough examination is to be made, and the line of treatment finally decided upon, and this must be done in as aseptic a manner as possible. If a large artery has been wounded, the first thing is to secure it above and below ; the tourniquet can then be removed. The wound should now be washed out with an antiseptic solution. Corrosive sublimate is probably the best, not only on account of its proved antiseptic properties, but because it can easily be transported in the form of tabloids, one of which dissolved in a pint of water gives a solution of the strength of 1 in 1,000. The first point to determine is the presence or absence of the bullet. In a large number of cases this is at once done, the presence of two wounds indicating that the bullet has passed through. If not, the wound must be explored for this purpose, and the finger will usually be found the best means of doing this, and in very many cases it cannot be improper to enlarge the wound for this purpose. Numerous other means of exploration have been advocated : Nelaton's porcelain probe ; Lecompte's 'stilet-pince,' by which a portion of the foreign body may be nipped off ; and Ruhmkorff's and De Wilde's electric indicators, have all been used, but none give such satisfactory results as the finger. In gunshot wounds, in the future, the X rays will prove of efficient service in detecting the bullet. The bullet having been found must then be extracted by bullet forceps, of which those known as Coxeter's are usually found to be the most effective (fig. 20). By this examination with the finger the surgeon can ascertain not only the position of the bullet, but also the extent of the injury, whether any bone has been comminuted, or large joint damaged, or viscus injured, and can determine, in wounds of the extremities, whether amputation is necessary. No strict rules can be laid down for this ; each case must be settled on its own merits ; but this may be said : that

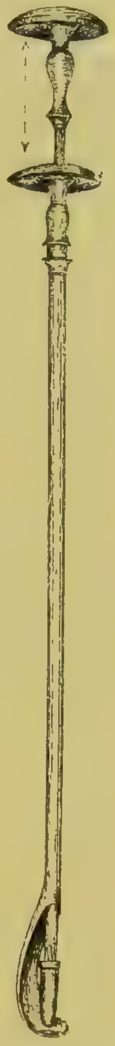
FIG. 20.—Coxeter's bullet forceps.

the results which follow primary amputation are much more satisfactory than those where secondary amputation is performed. Where amputation is not required the wound must be treated on ordinary surgical principles; the main points to attend to are absolute rest, free drainage and strict asepsis. By these means inflammation may be limited, and sloughs, if they form, separated with a minimum amount of suppuration.

2. **Injury by explosive shells.**—The injury is produced by the impact of the fragments, into which the iron casing of which the shell is composed breaks up upon its explosion, and the damage depends upon the number and size of the fragments which strike the individual. They produce some of the most terrible wounds met with in war. They inflict lacerated wounds of very irregular shape, in which large portions of tissue, or even an entire limb, may be torn away. They may splinter a bone in every direction, or they may reduce the body to a shapeless mass. Sometimes if a small piece of shell strikes an individual it may pass through, making a wound of entrance and a wound of exit, both of which are large and ragged. But as a rule, though they produce severe laceration and may penetrate tissues to a considerable extent, they rarely pass through them.

3. **Injury from small shot.**—Injuries produced by the discharge of small shot from a fowling piece are the most frequent form of gunshot wounds which are met with in civil practice. The amount of damage which is done depends upon the distance at which the gun was discharged. If the person wounded is within a few feet of the muzzle of the gun at the time of the explosion, the injury produced is of the most extensive character. The charge of shot enters the body like a solid mass of metal, and then spreads in all directions. Here the entrance wound is large and its edges crenated, because the shot have already begun to spread a little; unless the muzzle is quite close to the individual, when the mass of shot makes a wound like that produced by a fragment of shell. The exit wound is very large and irregular, and its margins have a sieve-like appearance from isolated shots passing out. When the gun is fired from a considerable distance, the shots spread as they fly, and produce a number of wounds, which usually do not penetrate beyond the subcutaneous tissue. Here they rarely do any harm, unless they suppurate. Sometimes a shot may chance to strike an important part, as the eye, and the sight may be destroyed.

CICATRICES AND THEIR DISEASES

We must not leave the consideration of wounds without saying a few words upon the diseases of scar tissue. As we have already seen, scar tissue is formed from the connective tissue cells of the part, and consists of a lowly organised fibroid material, which is a distinct retrograde change from the normal tissues. The diseases to which it is liable are therefore, as we should naturally expect, diseases of degeneration. The three diseases to which cicatrices are liable are: (1) Ulceration, (2) Keloid, and (3) Epithelioma.

1. **Ulceration.**—The most common complication of a scar is ulceration. This only takes place in large scars which have formed from wounds where there has been considerable destruction or removal of skin, so that the edges of the wound cannot be approximated, and is particularly liable to occur after burns, and is evidently due to the low organisation of the

scar tissue, since the ulceration usually commences in the centre of the scar at the point farthest removed from the normal circulation. These ulcers are very sluggish and slow to heal, and when healed apt to break down again and recur. These facts should always be borne in mind by the surgeon, and whenever he has a case where there has been considerable destruction of the skin, and a large granulating sore exists, he should resort to skin grafting, which not only hastens the healing of the wound, but also promotes a sounder scar, which is less liable to undergo degenerative changes.

2. **Keloid** is a disease of cicatrices, which consists in an overgrowth of the scar tissue, and must also be regarded as a disease of degeneration, for though there is an excess of growth, this growth consists of a lowly organised fibroid material intermingled with cells, which are arrested in their progress of development and degenerate in their incomplete forms. In these cases hard projections grow from the margin of the scar; they are smooth, red, and glistening, and as they grow they send forward claw-shaped processes, which grow into the adjacent skin (fig. 21). They may extend over a considerable area and produce great deformity. They are painless, but liable to ulcerate and bleed. They appear to be dependent on some constitutional condition, and seem to be especially associated with the tuberculous diathesis; at all events they are especially liable to occur in the cicatrices of tuberculous ulcers. The treatment of this condition is not very satisfactory. Their removal may be, and often is, followed by a recurrence of the growth in the scar of the operation, and, if sutures are used, in the punctures made by the needle. Pressure is followed by the best results, and is supposed to act by starving the growth, but unfortunately this plan of treatment is often followed by ulceration if the pressure is at all severe, and the ulcers are slow to heal. Flexile collodion appears to be the best application, as when it dries it contracts, and so constricts the vessels. I have found in one or two instances marked benefit from the internal administration of arsenic, and cod liver oil has been recommended by some under the supposition that the disease is connected with the tuberculous state. In some instances, keloid tends to disappear spontaneously.

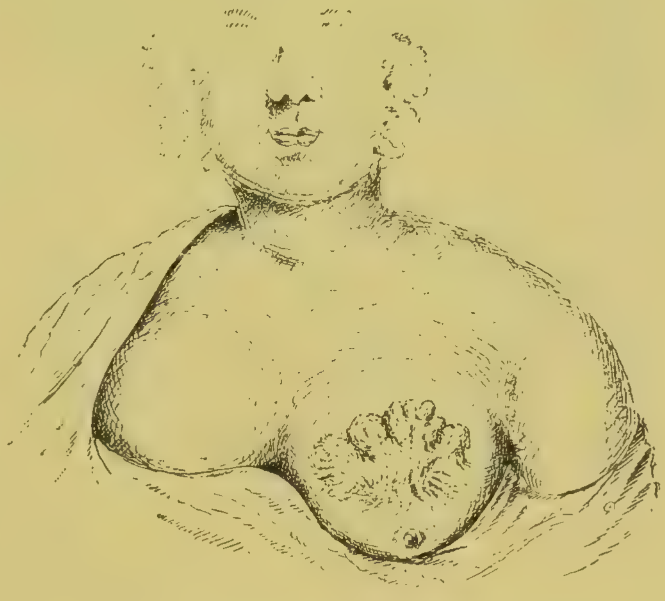

FIG. 21.—Keloid of the breast.
(From a drawing in the Museum of St. George's Hospital.)

3. **Epithelioma** is apt to attack scars, especially if they are subjected to any external source of irritation. This condition was first accurately described by Mr. Cæsar Hawkins as 'warty tumours of cicatrices,' but it

is a true squamous epithelioma, which shows itself first as a warty growth from the surface of a scar; this speedily ulcerates and soon presents all the characters of an epithelioma. As Mr. Hawkins pointed out, the glands are not early affected in this form of the disease. The only treatment which holds out any prospect of success is early and free removal, and this when the disease occurs on one of the extremities is best accomplished by amputation.

Neuralgia of scars is another condition which requires incidental mention. It generally arises from implication of some divided nerve fibres in the cicatrix. It was not uncommon in the olden times after the operation of venesection from the median basilic vein, from implication of some branch of the internal cutaneous nerve. The best remedy is to remove the scar and employ skin grafting to the resulting raw surface.

Contraction of Cicatrices.—We have seen that scar tissue after its formation has a tendency to contract. When a large surface of skin has been destroyed, and the resulting scar is of considerable extent, this contraction may be very great, producing the gravest deformities. As this condition is generally the result of burns and scalds, it will be considered with these affections.

BURNS AND SCALDS

Burns are produced by the application of dry heat; scalds by the application of moist heat, that is, hot liquids or steam; but pathologically and clinically they may be regarded as the same thing, except that, inasmuch as the degree of destruction of tissue depends not only upon the intensity of the heat, but also on the duration of its application, scalds are generally milder forms of injuries than burns, since the hot liquid rapidly runs off the body and quickly cools. This does not apply to molten lead, which adheres to the part, and retaining its heat for a long time destroys the tissues to a great depth.

Burns are classified according to their depth, and the classification of Dupuytren, who divides them into six degrees, is the one usually adopted.

1. In the *first degree* there is no destruction of tissue. It is, in fact, a mere scorch, produced by the momentary action of heat. There is superficial hyperæmia, indicated by redness. The scorched epidermis may subsequently desquamate, but beyond this no trace of the injury remains.

2. In the *second degree* there is destruction of the cuticle. The cutis beneath it inflames, with the result that exudation of serum takes place between the cuticle and cutis, forming blisters or blebs. Fresh epithelium forms over the cutis, the separated cuticle is cast off, and no mark or scar results beyond sometimes slight discolouration. If the cuticle is torn off or removed before the fresh epidermis is formed, the raw surface may become more inflamed and discharge a little puriform fluid.

3. In the *third stage* a part of the thickness of the true skin is destroyed, but not the whole. This destroyed tissue separates, and after it has done so the deeper layers of the cutis vera, containing elastic tissue, hair follicles, and sebaceous glands, remain, and are quickly covered by granulations, which discharge pus and rapidly cicatrise. No contraction results because there has not been destruction of the whole thickness of the skin, but a visible cicatrix remains.

4. In the *fourth stage* there is destruction of the whole thickness of the skin, and the subcutaneous tissue is exposed and perhaps slightly implicated.

The destroyed tissues separate by ulceration, leaving behind a granulating surface with large florid granulations, which bleed easily; heal slowly; and form a thin, unhealthy cicatrix, which is prone to break down and ulcerate. In these cases the cicatrix has a great tendency to contract because it consists of fibrous scar tissue, instead of, as in the third degree, elastic connective tissue.

The essential point of difference, therefore, between burns and scalds of the third and fourth degree, and one which it is important to bear in mind, is that in those of the third degree there is no contraction, whilst in those of the fourth there is, with resulting deformity. Another point of difference may be noted. Burns of the third degree heal readily; those of the fourth degree slowly. The former heal rapidly because a certain amount of epithelium is left undestroyed in the hair follicles and between the papillæ, from which cicatrisation starts.

5. In the *fifth degree* the whole of the subcutaneous tissue down to the deep fascia, and sometimes even this, is destroyed.

6. In the *sixth degree* there is charring of the whole limb. In these last two degrees there are the same local changes as those which took place in burns of the fourth degree; namely, separation of the dead tissue by a process of ulceration, leaving a granulating surface covered with large, florid granulations; a slow process of cicatrisation; the formation of a lowly organised cicatrix, which has a tendency to contract and produce deformity.

Constitutional effects.—The constitutional effects of burns depend upon the extent and perhaps to a certain degree upon the situation, rather than upon the depth. A superficial burn over a considerable portion of the body produces far graver constitutional effects than a very deep burn, or even complete charring of a small portion, say a hand or a foot. It is usually stated that if one-third of the body is burnt or scalded, even to the second degree, the patient rarely recovers, and we cannot be surprised at this when we remember what an important excretory and respiratory organ the skin is. Patients do, however, sometimes recover after the most extensive burns. I have had recently under my care in St. George's Hospital a man who was scalded to the second and third degrees by falling into a vat of hot water, as high as the level of the nipples, and who recovered. The constitutional symptoms were of the gravest type, and for some days he was violently maniacal. The situation of the burn is also said to have some effect on the constitutional condition: burns and scalds of the upper part of the body, the head, face, neck, and chest, are regarded as more serious than those of the extremities or abdomen. The age of the patient has also some bearing in the same direction. Children, who unfortunately are often burnt, suffer very severely, and in old people the collapse which follows is often very severe and frequently fatal.

The constitutional effects of burns may be conveniently considered under three heads: (1) stage of collapse or shock; (2) stage of reaction; (3) stage of exhaustion.

(1) **Stage of collapse.**—Directly after the receipt of the injury the patient becomes faint and collapsed, is often attacked by rigors if an adult, or by convulsions if a child. The surface of the body becomes bedewed with a cold and clammy sweat. Generally severe pain is complained of, and this is especially great in burns of the second and third degree, where the nerve endings are exposed and injured, but not destroyed. Sometimes, however, no pain is complained of, though the

patient may be perfectly conscious. The temperature is subnormal; the pulse very rapid and scarcely to be felt; the respirations quick and shallow. The tongue and mouth are dry, and great thirst is experienced. Vomiting often occurs, and involuntary passage of the urine and fæces. There is extreme mental depression and often delirium. In this stage many cases prove fatal, great restlessness setting in, followed by stupor, coma, and death. At the post-mortem examination nothing is found except congestion of the internal organs, especially the brain, where blood-stained serum may be found distending the ventricles. Dr. Burdun has recently examined the bodies of five children, who died within a few hours of receiving extensive superficial burns. He found swelling of the lymphatic glands throughout the body, and also of the gastro-intestinal lymph follicles. He considers that the changes seen were very similar to those observed after fatal cases of certain fevers, the main effects of which are ascribed to toxic substances circulating in the blood, and he attributes the death in these cases to toxæmia.[1] Should the patient not die, reaction sets in, in about twenty-four to forty-eight hours.

(2) **Stage of reaction.**—This is accompanied by local inflammation. The parts around the burnt surface become red, swollen and painful, and the sloughs begin to decompose, usually with a very offensive odour. Fever now sets in, due to the absorption of the chemical products of putrefaction, and is therefore a true septic traumatic fever. It is proportional to the extent and depth of the burn. The symptoms are those of ordinary traumatic fever, with special symptoms dependent upon inflammatory affections of the internal organs. These are obscure at first, especially as a physical examination cannot often be made. There may be inflammation of the gastro-intestinal mucous membrane or peritoneum, or of the lungs or pleura, or the kidneys may be affected, denoted by the presence of albumen and sometimes blood in the urine. The brain is not so frequently implicated, even when the burns are on the scalp. Amongst these conditions must be mentioned perforating ulcer of the duodenum, which appears to have attracted more attention than its rarity would seem to merit. It consists in ulceration of the mucous coat of the bowel, which gives rise to no special symptoms until the ulcer either perforates through the coats of the intestine and sets up a rapidly fatal infective peritonitis, or else perforates into one of the large duodenal vessels, causing death from hæmorrhage. Neither of these sequelæ necessarily takes place, for cases have been recorded where cicatrices have been found in the duodenum of patients who have been burnt and have died from other causes. Some authors state that it is not absolutely limited to the duodenum, though certainly this appears to be the most common situation where it is found. The accepted opinion of the pathology of this condition is that the circulation in patches of the mucous membrane becomes arrested as the result, partly of a congested condition of the gastro-intestinal mucous membrane, and partly from the presence of a septic poison in the blood, and that these thrombosed patches are digested by the action of the gastric juice. The old idea that the disease began as a congestion of Brunner's glands, which had been called into excessive action by the destruction of the sweat glands of the skin, has been quite discarded.

(3) **Stage of exhaustion.**—The stage of exhaustion usually commences about the time the sloughs have separated, usually towards the end

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[1] *British Medical Journal*, February 5, 1898.

of the second week. It is due to the excessive discharge which is caused by the introduction of bacteria into the wound. It may terminate in septicæmia or pyæmia if the bacteria effect an entrance into the circulation; or the patient may get weaker and weaker and develop a condition of hectic, which is probably also a form of septic poisoning, from which he may succumb. Death is frequently induced in these cases from a low form of inflammation of the lungs or pleura, or from exhaustion. Lardaceous disease of the viscera not unfrequently also terminates the existence of the patient.

Treatment.—The treatment of burns and scalds must be both local and general.

The **local** treatment must mainly be directed to the prevention of sepsis, except in burns of the first and second degree, when this is not to be apprehended. In burns of the first degree the only indication is to exclude the air, when the pain will rapidly subside. Dusting the part with some simple powder or the application of warm Goulard lotion, to which if desirable a little laudanum may be added, is all that is necessary. In burns of the second degree, the blister should be punctured so as to allow the fluid to drain away, but the cuticle should on no account be removed, as it forms a protection to the sensitive denuded papillæ underneath. The part should then be covered with some simple ointment—boracic ointment is perhaps the best—and swathed in cotton wool, which may be left undisturbed for a few days, by which time fresh epithelium will have formed over the denuded papillæ and no further treatment will be necessary. In the severe forms of burns, sepsis is to be feared, and every means should be taken to avoid it as far as possible. Many different applications have been recommended. It must be borne in mind that the surface of a burn is a very absorbent one, perhaps as much so as the raw surface of a wound, and therefore it is not safe to use antiseptics possessing toxic principles, such as carbolic acid, corrosive sublimate, and iodoform.

The remedies usually employed are boracic acid, salicylic acid, picric acid, eucalyptus oil, and creolin. The use of picric acid has in my hands been so satisfactory, that I do not think it is necessary to do more than allude to the other non-toxic antiseptic remedies. I must mention, however, that other remedies are also constantly employed, of which Carron oil is perhaps the favourite. It consists of equal parts of boiled linseed oil and lime water. It is anodyne, but possesses no antiseptic properties.

The plan which I adopt is first of all to immerse the patient in a hot boracic bath, which relieves the pain and collapse, or thoroughly sluice the burnt parts with boracic acid lotion, and then cover them with lint soaked in picric acid solution. This solution is prepared by dissolving 5 grammes of powdered picric acid in 80 grammes of rectified spirit, and then adding 1,000 grammes of boiled distilled water. The solution of the acid in the spirit should be kept in stock, and the water only added when the lotion is required. Over the lint thus applied a layer of jaconet or other waterproof material is placed, and the whole swathed in a thick layer of cotton wool and bandaged. The first dressing may be allowed to remain undisturbed for three days, when it must be removed, and after this the parts must be dressed daily in the same way. The dressing is anodyne and antiseptic: by its use the severe pain is materially relieved, the sloughs separate with a small amount of suppuration, and there is little or no fever. I have treated a large number of cases, especially children, in this way, and have had no cause to be dissatisfied with the result. The only objection is that the picric acid stains the bedclothes and night-dress of the patient, and therefore caution must be exercised in its application.

As cicatrisation advances, every care will have to be observed by the surgeon to prevent contraction and the serious deformities which result therefrom. This may be done to a certain extent by properly adjusted splints and weights, but much more is to be done in preventing them by employing the method of skin grafting recommended by Thiersch, and which will be described on a future page. By doing this, non-contractile natural skin is substituted for the contracting cicatricial tissue which would otherwise fill up the wound. Not only does skin grafting prevent in a great measure the deformity, but it also hastens the process of cicatrisation.

General treatment.—In the stage of collapse a full dose of opium in some hot brandy and water must be administered by the mouth, or, what perhaps is better in most cases, as an enema by the rectum. If the collapse is very extreme, hypodermic injection of strychnine and ether, as recommended in the section on Shock, must be resorted to. During the second stage, whilst the patient is in a condition of reaction, all that is necessary is to attend to the secretions, and keep the patient on a fluid nutritious diet, husbanding his strength for the stage of exhaustion through which he will have to pass. In the third stage, the patient must be treated on general principles with tonics—quinine, bark and ammonia, or the mineral acids—stimulants, and nutritious, easily digestible food. Occasionally, if there is much irritability of the nervous system, opium or the bromides are indicated.

Primary amputation is seldom called for in burns, unless it be of a single finger or toe, for if the burn has been so severe as to disintegrate a limb the condition of the patient is such as to negative the performance of an operation.

Contraction of cicatrices after burns.—As we have already stated, the cicatrices of burns are liable to undergo a great amount of contraction, and produce the most unsightly and distressing deformities, particularly when the burn has been on the front of the neck or at the flexures of the joints. In the former case the lower lip is depressed, presenting its mucous surface externally; very often the chin is drawn down and the mouth cannot be closed, causing constant dribbling of the saliva, and a very hideous deformity (fig. 22). Where the burn is at the flexure of a joint, bending of the limb takes place, and it cannot be straightened. For

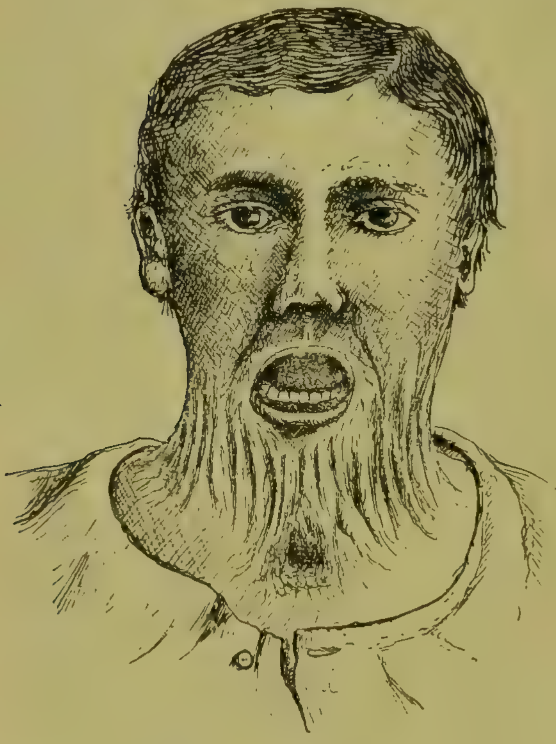

FIG. 22.—Deformity produced by the contraction of a cicatrix from a burn. (From a cast in the Museum of St. George's Hospital.)

instance, in cases of burns at the front of the elbow, the forearm becomes flexed acutely on the arm and the limb comparatively useless, or burns in the groin may be followed by flexion of the thigh on the pelvis, and ordinary progression rendered impossible. Unfortunately, the results of operation are not very satisfactory in these cases. They are conducted on two principles. One is to divide the contracted cicatrix freely across, and then stretch the part and allow the diamond-shaped wound thus made to heal by granulation. The great objection to this plan is that the cicatrix which forms has the same tendency to contract as the former one had, so that in many cases where this plan has been adopted, the deformity in the process of time has become as bad as ever. The second plan is to divide the cicatrix as in the first proceeding, and then fill in the gap with a flap of skin transplanted from some other part of the body. This is the better plan of the two, and the one which is most frequently successful, but it does not always succeed in completely removing the deformity, though generally considerable amelioration can be obtained. It must be left to the surgeon to plan his flaps in each case according to its requirements, and only one or two broad principles of procedure can be alluded to: (1) the contracted tissue must be completely divided, not only in its breadth, but in its thickness, and no bands left in the deeper parts of the wound; (2) the flap must be cut larger than the gap it is intended to close, on account of the elasticity of the skin; (3) the flap must be accurately adapted, raw surface to raw surface, and held in position by sutures without tension; (4) there must be no stretching or tension of the tongue of skin which connects the flap to the rest of the body, otherwise the circulation in the flap will be interfered with; (5) strict asepticity must be obtained.

Lightning stroke.—Burns and accidents from lightning are not very common in this country, and vary much in degree. In all at the moment of the stroke there is a shock to the brain, which may be only slight and produce a momentary unconsciousness, or may be so severe that the person is killed on the spot. As a rule there is insensibility, which may last for a considerable time, accompanied by paralysis and loss of sensation, both general and special. The paralysis may last for months, and sometimes there is loss of sight or hearing, which may be permanent. The more local effects show themselves in burns. These burns may be very extensive, but are generally superficial, that is to say, of the first degree—the body is scorched. Sometimes it has been noted that this scorching is in lines, arranged in an arborescent manner, and this is believed to be a sort of photograph of neighbouring trees. Rarely bones have been broken by lightning stroke. If death is not immediate, recovery usually takes place.

In the post-mortem examination of those that have died, the blood has been found imperfectly coagulated, the heart uncontracted and empty, but no special or characteristic appearances.

FROST BITE

Frost bite is the name given to the local effects produced by the application of extreme cold to the body. They very much resemble burns and scalds, and like them vary in degree.

Frost bites occur in those parts of the body which are farthest removed from the central organ of the circulation, as in the hands and feet, the ears or tip of the nose. They are most common in debilitated individuals, drunkards, or those who have been depressed by the want of the necessities of life. They are also more frequent in the very aged, where the circulation is less active, and in young children.

If cold is applied to a part, it causes contraction of the blood-vessels, especially the small arteries, and the supply of blood is first diminished, and then, if the cold be sufficiently intense, the circulation is arrested and the part becomes white and its sensibility destroyed. But the part is not yet dead ; if the cold be withdrawn, the contraction of the vessels ceases, the blood again finds its way into them, and the white colour disappears and gives place to a vivid redness due to a dilated condition of the blood-vessels, and a hyperæmia, that is to say, the first stage of inflammation, is set up. If the impairment of the vitality of the tissues has been very slight, the process may go no farther, and the circulation gradually recovers itself; but if the vitality of the tissues has been more impaired, the first stage of the inflammation may pass on to stasis and exudation, and the pressure caused by the exudation may be so great that, in conjunction with the stasis of the corpuscles in the vessels, it may cause a second arrest of the circulation, and gangrene may be the result.

If, instead of the cold being withdrawn when the part becomes white, it is continued, then the vitality of the tissues will become so low that they will perish and gangrene will result. Thus it will be seen that gangrene may occur in two ways from the application of cold. First, the application of cold may be so intense and so long continued that it kills the tissues outright, without any attempt at recovery. In these cases the gangrene is of the dry variety, and this form is not very common. Secondly, the application of cold not being continued until the vitality is completely crushed out of the tissues, nature makes an effort, on its withdrawal, to restore the circulation, but owing to the damage done to the tissues the reaction runs on into inflammation, thrombosis, and gangrene. In these cases the gangrene is moist, and is especially liable to occur where the part after the withdrawal of the cold is suddenly exposed to too much warmth, as is so often done by ignorant persons in the hope of restoring the frost-bitten part.

Frost bites vary in degree. In the slightest degree there is merely a slowing of the circulation and no complete arrest. There is, in fact, a local passive congestion. The circulation through the arteries is diminished owing to their contraction, the vis a tergo is lost, and therefore the capillaries of the part become choked with blood. There is dusky redness, which, however, is obliterated by pressure of the finger, and therefore is merely due to slowing of the stream and not to stasis. There is swelling and œdema, and if the part be exposed to heat, intolerable itching. This condition, which is very commonly met with on the toes of ill-nourished children in wintry weather, is ordinarily known by the name of **chilblain.** In a severer form we have more damage to the tissues, and in addition to the redness and œdema we get vesication and occasionally a small slough of the superficial layers of the corium. This leaves a little ulcer which is very slow to heal and which is popularly known as a 'broken chilblain.' Thirdly, we get the true frost bite, in which there is death of various portions of tissue arising in one of the two different ways spoken of. The amount of tissue destroyed may vary : it may be a small piece, as the lobule of the ear or the tip of the nose; or it may be a finger or a toe, especially the great toe, or a whole limb may perish. The part becomes swollen and black, or may become dry and shrivelled, and separates tardily, leaving an ulcerated surface, which is very slow to heal.

Treatment.—In the treatment of frost bite, the first indication is to endeavour to restore the vitality of the frozen parts, and this must be done with the very greatest care. The natural impulse would be to apply as much warmth as possible; but if this is done, inflammation is sure to occur, with attendant thrombosis, and the inevitable occurrence of gangrene. The circulation should be restored as slowly as possible, by keeping the patient in a cool room and rubbing the part with cold fur or flannel, or, as is frequently recommended, with snow. If the patient is much depressed, a little cold brandy and water may be given. As the parts recover themselves, much tingling and even pain will be complained of. As this passes off, he may be brought into a warmer room, and the part wrapped in dry flannel or wool. If in spite of this treatment the frozen part perishes, the case must be treated in the same manner as a burn, care being taken to preserve asepsis as much as possible during the separation of the dead parts. In some of these cases the question of amputation may arise. The rule is not to perform this until the line of demarcation is formed, for it is impossible to tell how far the gangrene may extend, and the surgeon might remove too much or too little. When the line of demarcation has formed, the sooner the condemned part is removed the better.

SECTION III

GENERAL DISEASES

CHAPTER I

SUPPURATION—ULCERATION—MORTIFICATION

Suppuration may be regarded as being due to the continuance of the process of inflammation. In our examination of the phenomena of inflammation we found that if it was slight and non-persistent the amount of inflammatory exudation which took place was also slight, and resolution or retrogression was the result; but if it was more severe and persistent, a fluid was produced which we term *pus*. If the inflammation is on the surface of the body, so that the resulting fluid—pus—can at once escape and be got rid of, we have the condition known as *ulceration*, which will be considered immediately. If, on the other hand, it occurs in the substance of the tissues, and the pus cannot be got rid of, we get one of two conditions; either the pus is contained in a closed cavity, which we call an *abscess*, or it is diffused through the tissues, distending them, without in any way being circumscribed, and this we know as *diffuse suppuration*.

Characters of pus.—Pus is an opaque, creamy fluid. It is yellowish-white in colour, and feels greasy, owing to the fatty matter which it contains. It has, when fresh, a faint sickly odour, due to the presence of ammonia, which is one of the products of the pyogenic micro-organisms. It is alkaline in reaction, and is of the sp. gr. of about 1030°. It contains about 88 per cent. of water; albumen, fatty matter, and cholesterin; sodium chloride and other alkaline salts, and a small amount of earthy phosphates and iron. This is what is termed *laudable* pus, and it is the result of acute suppuration in a healthy subject; but many other varieties are spoken of: thus when it is thin and watery it is termed *sero-pus* or *ichorous* pus; when it is tinged with blood, *sanious* pus. Pus sometimes presents peculiarities in colour: it may be of a blue colour, due to the presence of a special micro-organism; when it comes from an abscess in the loin, it is of a reddish yellow colour. The so-called pus which is found in tuberculous abscess is known as *curdy pus*.

Pus consists of corpuscles floating in a clear fluid, the *liquor puris*. The corpuscles resemble in size and character the white corpuscles of the blood, and are indeed, for the most part at all events, the leucocytes which have emigrated from the vessels and have then died. They are rounded or slightly irregular in their outline, about $\frac{1}{2500}$ of an inch in diameter, and consist of a mass of nucleated protoplasm without any cell wall. The protoplasm is coarsely granular, and contains a large number of highly refracting particles—fat granules—especially in old pus, which may completely obscure the nucleus. On the addition of acetic acid this body becomes visible, and in the typical cell is seen to be a lobed or tripartite body without nucleolus (fig. 23).

Etiology of suppuration.—I have said that suppuration may be regarded as being due to the continuance of an inflammation, and the essential cause of this continuance is the presence of micro-organisms of a specific nature, to which the term *pyogenic* is given. These organisms are constantly found in the pus of acute suppurations, not only free in the liquor puris, but also embedded in the protoplasm of the pus cells. They present considerable variety, but there are three principal ones which are the most common and which it will be sufficient to describe in this place. The others, such as the micrococcus pyogenes tenuis, the bacillus fœtidus and pyocyaneus or organism of blue pus, would appear to be less virulent and to occur much more rarely. Of the three principal varieties, two belong to the class of Staphylococci and one to the class of Streptococci.

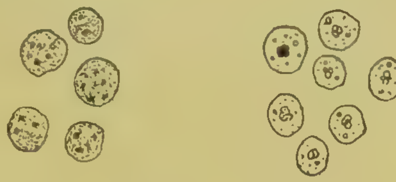

FIG. 23.—Pus cells. Those on the left-hand side of the diagram are before the addition of acetic acid; those on the right, after the addition of the acid.

The *Staphylococci* consist of organisms heaped together in an irregular mass, and have received their name from their fancied resemblance to a bunch of grapes. The two principal varieties which are concerned in the production of pus are S. pyogenes aureus and the S. pyogenes albus, and they are distinguished by the colour which they produce under artificial cultivation. They give rise to localised suppurations, and therefore may be regarded as the causal agent of acute circumscribed abscesses. The S. pyogenes aureus is more commonly met with than the albus. The *Streptococci* are found in about 16 per cent. of all acute suppurations. They tend to arrange themselves in the form of a chain, and hence their name. They spread widely along the lymph spaces and give rise to diffused suppuration, and therefore are always present in the diffuse suppuration of cellular tissue.

The pyogenic organisms may find their way to the part by several different routes. If there is an open wound they may be introduced from without, either from the air, or the water which has been used to bathe the wound, or, what is more probable, from the skin of the patient or the hands of those who have touched the wound. If there is no wound, the micro-organisms may be conducted to the inflamed part in different ways: they may effect an entrance through the alimentary canal or air passages, and be carried by the blood to the part; or they may find their way into the lymph stream, through some accidental abrasion of the skin, and be carried by it to the affected part; or finally, as in mammary abscess, they may find their way down the ducts which open on the surface of the body.

We have now to say a word or two on the part these organisms take in causing suppuration. Having reached the inflamed part, where the tissues have been vitiated and weakened by the inflammatory process which has been going on, they find a condition of things which is favourable to their growth; for it must be mentioned that though suppuration cannot occur without the presence of these micro-organisms or their products, still these organisms may be present and no suppuration occur, and conditions exist in which they are powerless to act. Probably a weakened state of the part, the result of a previous inflammation, is one of the most important conditions which favour their action. Suppose, then, we have some part in which an inflammation has been set up by a mechanical irritant, and in which there has been hyperæmia and then stasis and migration of leucocytes, and in which, therefore, there is a degenerated vitality or weakening of the tissues. In this weakened tissue the pyogenic organisms find a suitable habitat and commence to grow and form their products. In consequence of this, the diapedesis, which under ordinary circumstances would have soon ceased, continues, and the part becomes crowded with round cells. This continued migration of the leucocytes is supposed to be due to positive chemiotaxis; that is to say, to the attractive influence exerted by the products of the growth of the micro-organisms on the amœboid cells. So numerous are the cells which crowd the part that the original tissue is quite obscured. These cells absorb the original tissues and occupy their place. Whether these tissues have first been killed by the action of the products of the organisms, and the leucocytes only remove the necrosed tissues; or whether the leucocytes destroy and replace the living tissue, is not quite certain; but at all events, at this stage of the process, in the centre of the inflamed area, a part will be found in which all trace of tissue has disappeared and been replaced by living cells, in other words a cavity containing leucocytes (fig. 24); outside this is a zone of tissue, in which there is nothing to be seen but round cells, but in which some of the original tissue still remains holding the cells in its meshes. And again, outside this, another zone, in which there are not quite so many cells and some trace of tissue is to be seen: swollen and vitreous, but with its connective tissue corpuscles unchanged. Finally, on the outer surface of this is a further zone, where the vessels will be seen choked with leucocytes, which are rapidly undergoing emigration through the walls of the vessels and beginning to infiltrate the tissues. In the centre of this area, that is to say, in the cavity containing leucocytes, owing to want of nutrition or as a result of the action of the products of

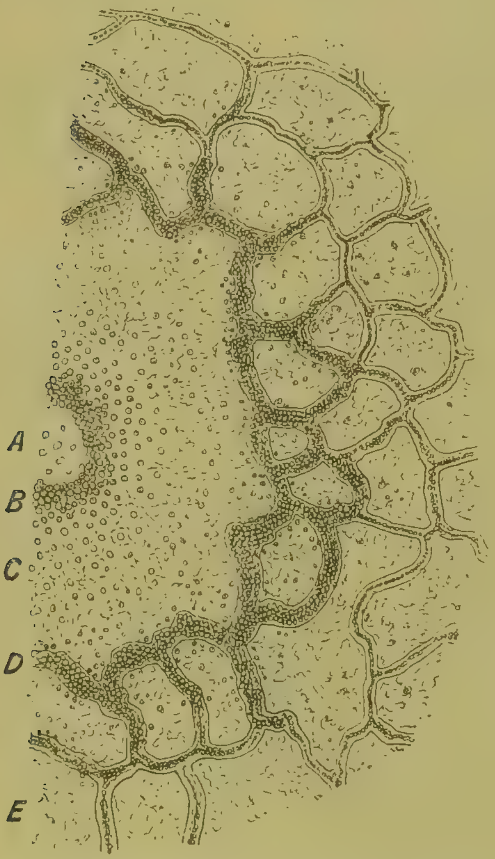

FIG. 24.—Diagrammatic representation of the minute changes in the formations of an abscess. A, abscess cavity; B, zone of round cells; C, zone of connective tissue infiltrated with round cells; D, zone of tissue in which the vessels are choked with corpuscles; E, normal tissue.

the micro-organisms, the cells die; the fluid which has passed out of the blood-vessels as the result of the inflammation, and which has been prevented from coagulating by the peptones resulting from the growth of the organisms—for they have the power of peptonising albumen—soaks in, and the cavity contains a fluid in which are numbers of dead leucocytes, i.e. pus, and in this way an acute abscess is formed.

It remains now only to consider the fate of the micro-organisms, and this is by no means certain. It may be that, adopting Metchnikoff's view of phagocytosis, they are destroyed by the leucocytes; or it may be that the serum of the blood or materials formed by the breaking up of the corpuscles destroys them; or it may be that in their growth they themselves develop products which are hostile to their own existence, as is known to be the case with some other micro-organisms.

Abscess.—Two perfectly different conditions are classed together under one designation, namely, Abscess. These two conditions are named respectively Acute and Chronic Abscess, but they differ essentially from each other in their pathology, their symptoms, and their treatment. The acute abscess is the one which is connected with the process of suppuration we have just been considering, and is formed in the manner which has been described. This we shall first consider, and then turn our attention to Chronic Abscess.

Acute abscess.—The **symptoms** of acute abscess may be considered under two heads: (1) Local and (2) constitutional.

The **local symptoms** or **signs** of acute abscess are those of inflammation: pain, heat, redness, and swelling. They differ, however, in character from those of acute inflammation, unattended with suppuration. The pain is altered; it is at first dull and aching, and then throbbing. The swelling, which in simple inflammation is hard and brawny, is soft and fluctuating at the centre, and the skin over the swelling is œdematous; instead of being diffused, it is more localised. The redness is of a more dusky hue. Fluctuation is perhaps the sign which is most relied upon as indicating the presence of pus, and is perhaps the one in which error is most likely to creep in, as, unless the abscess is near the surface, it is not always easy to detect it. If the fingers of one hand are placed upon the swelling and those of the other made to press upon it in another part, a wave of fluid will be set in motion by the latter, which will be felt by the former, and the sensation thus produced is termed fluctuation.

The **constitutional** symptoms are those which have already been referred to in the section on Inflammation. The most characteristic of these symptoms is the occurrence of a rigor, though this does not occur in every case, for more commonly there is merely a feeling of chilliness. A *single* rigor is the indication of suppuration; *repeated* rigors point rather to general blood poisoning. The temperature rises considerably, to 102° F. or 103° F., and falls as soon as the pus is evacuated. If it does not, it indicates that there is still some matter retained in the wound. The evening temperature is higher than the morning one.

The **diagnosis** of acute abscess is generally easy, but occasionally difficulties are experienced and mistakes made. Fluctuation may be thought to be present when it is not really so: many other swellings give to the fingers an undulatory sensation which cannot always be distinguished from fluctuation; the presence of inflammatory infiltration in the subcutaneous tissues and soft tumours, e.g. some forms of sarcoma and fatty tumours, may give a sensation to the fingers very similar to that of fluctuation, and even a muscle when palpated transversely conveys a sensation very like fluctuation. It must be mentioned that fluctuation merely indicates the presence of fluid contained in a cavity; the nature of the fluid is known by the presence of the signs of inflammation. Perhaps the two most typical signs of pus are the presence of œdema in the skin overlying the swelling, and the presence of a softened spot, with an abrupt margin in an inflammatory area. Should any doubt arise in the surgeon's mind as to the presence of pus, it can at once be set at rest by the use of the exploring syringe—an exhausting syringe fitted with a sharp hollow needle. The needle is thrust into the swelling and the piston withdrawn, when the pus will be sucked up into the syringe, provided the lumen of the needle is sufficiently large to admit the passage of the fluid. The little puncture does no harm, and can be sealed with a drop of collodion.

Treatment.—There is only one treatment for acute abscess, and that is to open it as soon as the presence of pus has been recognised. There is no object in waiting, as the abscess will only increase in size and destroy more tissue, and the little operation is at once followed by immediate relief to both the constitutional and local symptoms. There are certain points even in the simple proceeding of opening an abscess which must be attended to. It must be done with those antiseptic precautions which have already been alluded to. The opening should be made at the point where fluctuation is most distinct, or at the most dependent part, and as far as possible from any of the muco-cutaneous orifices for fear of contamination from this source. The opening should be free; if the abscess is of any size, free enough to admit of the introduction of a finger. Except the abscess is small and superficial, it is always desirable that the finger should be inserted into it, since in many instances abscesses are loculated or present recesses, and unless the septa between these are broken down with the finger, all the pus will not be evacuated. After the abscess has been opened and the pus discharged, the cavity should be syringed out with some antiseptic fluid until it returns quite clear. A drainage tube should now be introduced into the bottom of the cavity; all remains of the fluid squeezed out, and the wound dressed antiseptically. The dressing should be changed daily, and the drainage tube shortened at each dressing, so that it can be left out altogether in about a week or ten days.

Sometimes, where the abscess is in the neighbourhood of important structures, the safer plan is to open it by the method advocated by the late Mr. Hilton. An abscess in the axilla, for instance, may be opened as follows: an incision is made through the skin and fascia, and then a director, introduced through this opening, is pushed onwards, with a boring movement, until pus is seen in the groove of the instrument: a pair of sinus forceps is then run along the groove, and when it enters the cavity is opened and forcibly withdrawn so as to enlarge the opening.

Chronic abscess differs in its pathology, symptoms, and treatment from acute abscess. It seems a pity, therefore, that they should be called abscesses, which they are not, if we accept the usual definition of an abscess—that is, a circumscribed collection of pus—for these chronic abscesses either do not contain pus, or if they do, it is only owing to some accidental circumstance. There is, however, a rare form of disease occasionally seen in the breast and it may be in bones, which more nearly merits the name of chronic abscess. Taking the breast for an example, we occasionally get a very hard tumour, which may be and often has been mistaken for a scirrhous tumour, and which when removed is found to be a sac containing pus with exceedingly hard, dense walls. This is supposed to have arisen from an acute abscess, which has undergone an abortive process from the death of the micro-organisms. The suppurative process has therefore been arrested, and consolidation of the surrounding connective tissue has taken place, causing the pus, which had formed before the death of the micro-organisms, to become inclosed in a wall of dense fibrous tissue. But the chronic abscess as we ordinarily see and understand it is a mass of tuberculous material with a softened centre, and the fluid it contains is caseated tubercle. In one point these chronic abscesses resemble the acute, and this is that the essential cause is a pathogenic organism, but in these cases the organism is the tubercle bacillus. This bacillus when it effects a lodgment in any tissue sets up an inflammation of a low and usually chronic type, which is marked by the production of a material called 'tubercle.' This tubercle when formed has a tendency to undergo fatty degeneration and become converted into a cheesy mass, which breaks down and leads to the formation of a curdy fluid, which is the so-called pus of one of these chronic abscesses. The wall of the cavity in which it is contained is composed internally of tuberculous material, which is undergoing the same caseating process, and outside this of a layer of newly formed fibroid material formed by inflammatory processes going on in the tissues around and set up by the irritation produced by the presence of the foreign body. The so-called pus (curdy pus) consists microscopically of fat granules and withered cells: sometimes a few true pus cells may be found; these have probably wandered in from suppuration of the inflamed tissues outside the tuberculous deposit. There are no micro-organisms in this fluid, not even the tubercle bacillus, which has been destroyed, and its spores only remain.

Symptoms of chronic abscess.—The only indication of a chronic abscess is the appearance of a fluctuating swelling, generally unattended by any heat, pain, or redness, in a case where there is some tuberculous affection, which is known to be often associated with the formation of chronic abscess. There are no evident signs of local inflammation or of constitutional disturbance as long as it remains unopened. A chronic abscess is liable to be mistaken for several other affections, and the diagnosis is not always easy to make. For instance, it may be mistaken for a soft tumour, such as a lipoma or a sarcoma; or it may be mistaken for some kinds of cysts, as an hydatid or a blood cyst. The diagnosis in many of these cases can hardly be arrived at without the aid of the exploring syringe, but this is almost always sufficient to clear up the point.

The **treatment** of chronic abscess is a matter of great importance. Formerly the opening of these abscesses was fraught with the gravest dangers, so much so that surgeons were very reluctant to interfere with them, and if they did so, resorted to all sorts of expedients to prevent the untoward results which so frequently followed; such as opening by a valvular incision; by means of an issue or seton; by tapping with a trocar and cannula; or by tapping under water. But in spite of these precautions the most serious results often followed. In some cases death occurred in a few days from profound septic intoxication from the rapid decomposition of the contents of the abscess and the absorption of ptomaines. In other cases violent suppuration was set up from the admission of septic germs, sometimes terminating in pyæmia, in others subsiding after a time as regards the acuteness of the symptoms, but leaving suppurating tracks, which went on discharging for a long time until hectic fever was set up, and this was followed by lardaceous disease of the viscera and the death of the patient. All this has now been materially altered by the careful aseptic treatment of these cases, and these conditions are rarely met with.

It is important to bear in mind, in considering the treatment of chronic abscesses, that it is not sufficient to evacuate their contents in order to get rid of the whole of the disease. As I have already pointed out, the so-called pus is caseated tuberculous material; but the whole of the tuberculous material is not liquefied, and the wall of the cavity is lined by a layer of the same matter, and our aim should be to get rid of this also. The best way of doing this, but one which can only be carried out in some cases, is to regard the swelling as a tumour, and treat it as such by dissecting it out. We have seen that outside the caseating tubercle there is a zone of newly formed fibroid material which forms a sort of capsule, which is sometimes so defined that the swelling can be dissected out like a cyst. In those cases, therefore, where it is anatomically possible to carry out this treatment, this is the plan which should be adopted; and there are a considerable number of cases in which it can be done, as in subcutaneous tuberculous abscesses of children; abscesses connected with caseating tubercle of glands; abscesses connected with superficial bones, as the ribs or metacarpal bones, &c. In the latter cases where it is connected with bone, the portion of bone implicated must be removed as well.

There are very many cases of chronic abscess which cannot be treated in this way. Take, for example, a psoas abscess, in which it would be impossible to dissect out the whole sac. Under these circumstances other means must be resorted to; always having the same end in view, namely, to get rid of the tuberculous material which lines the sac. And there are two plans of proceeding, both based on the same principles, which may be resorted to in these cases; one or other being employed according to the nature of the case. If the abscess is in some exposed part of the body and can be reached freely in its entire extent—such an abscess, let us say, as is connected with one of the bones of an extremity—it should be incised from end to end, so as thoroughly to expose it. The whole of the interior of the sac should be snipped away with scissors, or, where this cannot be done, diligently scraped with a sharp spoon, until every trace of tuberculous material is removed. In doing this, especial attention must be paid to the exposed bony surface, if there is one, and this must be scraped away until hard, healthy bone is reached. When the whole cavity has thus been thoroughly cleansed, it should be sluiced with a weak solution of corrosive sublimate to wash away all débris; dried; dusted over with iodoform and packed with iodoform or cyanide gauze. The packing may be left in for several days, and when removed a fresh packing should be introduced. Soon granulations will spring up over the surface of the sac, and the cavity fill up and heal in a very short time. The whole essence of this proceeding is in the free exposure of the interior of the sac; no part should be left which cannot thoroughly be explored by the surgeon, and all trace of diseased tissue removed.

In many cases it must happen that this plan of treatment cannot be carried out. In a case of psoas abscess, for instance, it is impossible to lay open and explore the whole of the sac; then less efficient means must be resorted to. An opening into the abscess should be made sufficiently large to admit a couple of fingers, and all the matter which will run out is allowed to do so. Barker's flushing gouge (fig. 25), which is hollow, and through which the cavity can be flushed while it is being scraped, should be introduced, and the whole of the interior of the abscess thoroughly and systematically scraped. While this is being done a stream of sterilised water at a temperature of 105° F. is made to flow through the gouge, which carries away the débris as fast as it is detached. After the scraping process is completed, it is washed out with a weak solution of corrosive sublimate and its walls well scrubbed with dry carbolic gauze, which is stiffer and rougher than cyanide gauze, and therefore better adapted for the purpose. The gauze is introduced in a loosely folded mass, the size of a walnut, on a pair of long clip forceps. When this has been completed, it is as well to flush the cavity with a little more corrosive sublimate solution, and then dry it and pack it with sponges to which pieces of silk have been attached, so that they can be easily withdrawn. Sutures are now introduced, but not tied. After they are all in their place, the sponges are to be removed, half an ounce to an ounce of 10 per cent. iodoform emulsion injected, and the sutures quickly tied and a dressing applied with plenty of wool and a firm bandage, so that as much pressure as possible may be made on the part.

In a very considerable number of these cases the wound unites by the first intention, no reaccumulation of fluid takes place, and the case is cured; but in a certain percentage of cases, though the wound heals by the first intention, a reaccumulation of the fluid takes place. The cavity then requires reopening, and the whole proceeding has to be repeated, and this may have to be done three or four times before a cure is effected. In some cases where probably there is some active mischief still going on, the wound does not heal, or if it does, breaks down again and begins to discharge. These cases must be treated by drainage; washing out the cavity daily with some antiseptic solution; of which I give preference to a solution of tincture of iodine (ʒi to Oj) and antiseptic dressing. The discharge may after a time cease and the wound do well, but they are unpromising cases and may terminate in hectic and lardaceous disease.

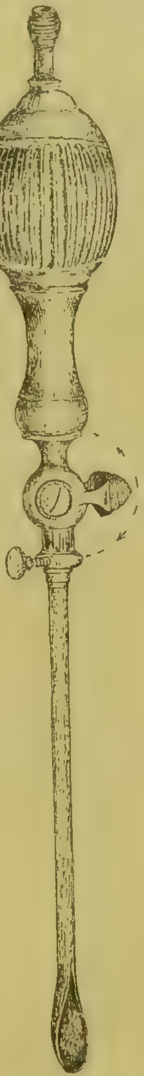

FIG. 25.—Barker's flushing gouge.

HECTIC AND LARDACEOUS DEGENERATION

Hectic is a chronic form of septicæmia, produced by the absorption of the chemical products of putrefaction. It therefore cannot occur until an abscess is opened and the bacteria of decomposition are admitted, and it generally occurs when the drainage is deficient, so that pus is retained in a cavity under a slight degree of pressure. It is a chronic process, and does not usually set in until suppuration has been going on for some time. It generally occurs in cases of chronic abscess, in which the wound has been allowed to become septic, and in which some of the discharge is not got rid of, but undergoes fermentation in the cavity of the abscess, and the products of this fermentation are absorbed under the pressure to which the pus is subjected.

The **symptoms** are characteristic, and are marked by evening exacerbations of fever, with morning recessions; and by progressive emaciation and exhaustion. A patient suffering from hectic, towards evening shows marked signs of fever; the temperature is three or four degrees above normal; the pulse is increased in frequency, small, and compressible; the skin is burning hot to the touch and the cheeks flushed; the eyes bright and sparkling, and the pupils dilated; the tongue is red, raw, and beefy. As night approaches profuse sweating occurs and the symptoms of fever disappear, and in the morning the patient is pale, weak, and languid, with a normal or almost normal temperature. The condition is accompanied by rapid and progressive exhaustion; the appetite is impaired and the patient fastidious about his food; there is often copious diarrhœa, which assists in exhausting the individual, and he dies either from sheer exhaustion or passes into a condition of lardaceous degeneration.

Treatment.—The treatment of hectic should aim at, if possible, removing the cause; and as we know that this is due to the fermentation of retained pus and the absorption of its products, our first endeavour should be, by free incision and careful drainage, to get rid of this offending material. It is a good plan as soon as hectic declares itself, if the patient can bear it, to lay the abscess cavity freely open, scrape away its walls, wash it out with some strong antiseptic, and powder the surface with iodoform or introduce iodoform solution, and employ free drainage. This treatment will, however, be quite futile unless all the recesses of the cavity are explored and dealt with. If the patient's condition will not stand such a radical proceeding as this, we must be content with daily irrigation with some antiseptic lotion and the insertion of large drainage tubes to the bottom of the cavity, so that the discharge may escape freely. At the same time we must employ such constitutional remedies as we possess. Quinine is perhaps the most valuable remedy in these cases, and the mineral acids alone or combined with bark are useful. The sweating may be checked to a certain extent by the administration of belladonna and by sponging the body with acetic acid or with vinegar and water. The diet must be light, easily digestible, and nourishing; food being given frequently in small quantities; and a liberal allowance of wine or brandy is generally required.

Lardaceous or Amyloid Degeneration.—Many cases of hectic terminate in a peculiar disease of the viscera, to which the name lardaceous or amyloid degeneration is given. This consists in a deposit in the viscera, especially the liver, spleen, kidneys, and intestines, of a peculiar substance, the exact chemical nature of which is unknown. It is an albuminoid, hyaline, structureless material which is insoluble in acids and alkalies, and has certain definite reactions to staining reagents. The most characteristic of these is the dark brown stain which it gives with iodine. The deposit first occurs in the walls of the smaller arteries, and from these it extends to the tissues around. The organs which it attacks become much enlarged. The liver, for instance, may attain more than twice its natural size, and in advanced cases the free border may extend considerably below the level of the umbilicus. After death it is found to be pale and waxy in appearance. The spleen also enlarges, but generally not to the same extent; the kidneys often become very considerably increased in size.

The exact **pathology** of the disease is unknown, but it is supposed to be due to some poisonous product of the micro-organisms which are maintaining the septic condition.

Symptoms.—A patient who has been suffering from some long-standing suppuration will be noticed to change in his appearance; he becomes pale and anæmic, his face presents a waxy appearance, and he will be found to be losing flesh. He complains of diarrhœa, having several liquid stools each day; if the urine is examined, it will be found to contain albumen and perhaps a few hyaline casts. Upon examination of the abdomen, enlargement of the liver may be made out. As the disease advances the pulse becomes very quick and feeble, œdema about the feet and ankles appears, and the patient dies of exhaustion.

Treatment.—The only treatment of any avail in this condition is at once to remove the source of suppuration, and if this can be done, even though there is advanced lardaceous degeneration, if the patient survive the shock of the operation, he stands a very good chance of recovering entirely and his viscera return to their normal condition. Unfortunately, in the great majority of cases this cannot be done, and then the case has to be abandoned as hopeless.

SINUS AND FISTULA

A **Sinus** or **Fistula** may be defined as a contracted abscess with one or more openings. This definition does not include congenital fistulæ, which belong to a different class and must be considered separately. The word sinus is generally applied to those cases of contracted abscess where there is only one opening on the surface of the body, and the word fistula to those cases where there is one opening on the cutaneous surface of the body, and another opening into some mucous tract. The terms are, however, somewhat loosely applied; for an incomplete or blind external fistula in ano ought, adopting this nomenclature, to be called a sinus.

An abscess forms as the result of some irritant; it is opened or bursts, but instead of healing up continues to discharge and contracts into a sinuous track or passage leading into the deeper tissues, with a small external opening. This is a sinus or fistula. The reasons why an abscess may refuse to heal are numerous. (1) The presence of a foreign body, as a piece of dead bone or a bullet, in the abscess. (2) The presence of tuberculous matter in the wall of the abscess. (3) The presence of an insufficiently drained cavity at the bottom of the abscess. (4) The contraction of neighbouring muscles, keeping up a perpetual condition of unrest. (5) The passage of any irritating fluid over the surface of the abscess. One of the most common causes of a sinus is a piece of dead bone. As long as this remains in the living tissues it excites a certain amount of irritation, and suppuration is kept up; the matter must find an exit, and therefore the abscess cannot heal. The opening of the sinus resulting from the presence of dead bone is generally funnel-shaped or depressed, and there are one or two florid granulations obstructing it. Another common cause of sinus is the presence of tuberculous matter in its walls. These occur in cases of chronic abscesses which have been opened. In these abscesses, as we have seen, a layer of tuberculous material forms the wall of the abscess, and when it contracts and forms a sinus the latter is lined with the same material, so that it cannot close. The imperfect evacuation of the discharge from an abscess also prevents its healing, and under these circumstances it contracts and forms a sinus.

A fistula is in some cases a sinuous track which communicates at one end with the cutaneous surface and at the other with some mucous tract, as salivary fistula, urinary fistula, fæcal fistula, complete fistula in ano: at other times it is a direct communication between two mucous surfaces, as vesico-vaginal or recto-vaginal fistula. The principal cause which produces these fistulæ—that is to say, which prevents the abscess from healing—is the constant passage of some secretion over the surface of the abscess; thus in the salivary fistula it is the saliva; in the urinary fistula it is the urine; in the fæcal fistula the fæces; and in the complete fistula in ano it is no doubt also to a certain extent the fæces. But there is also in some cases another cause which prevents the abscess closing, and this is the action of neighbouring muscles. To this cause we must attribute the non-closure of a blind external fistula in ano, and to a great extent the complete fistula in ano. The constant action of the sphincter ani keeps up a perpetual condition of unrest in the part, which prevents the healing of the abscess.

The walls of the sinus or fistula are lined with a thin layer of ill-formed granulation tissue, which was originally the wall of the abscess, and outside this, especially where the channel has existed for some time, is a layer of fibroid material which may sometimes be of considerable thickness.

The **treatment** of sinus or fistula consists essentially in removing the cause. If it is due to the presence of a foreign body, the body must be removed; if to the presence of tuberculous material or pus, this material must be got rid of; if to the passage of some irritating fluid over the surface of the sinus, means must be taken to prevent its passing over it; or if it is due to the contraction of neighbouring muscles, measures must be adopted to paralyse or prevent the action of these muscles. The details of the treatment of the various kinds of fistulæ will be considered in dealing with the surgery of the several tissues and organs, and nothing more need be said in the present place.

Congenital fistulæ.—There is another kind of narrow track met with sometimes, which is also unfortunately termed a fistula, though it differs in all essential points from the fistulæ we have been describing. These are the various forms of congenital fistulæ, commonly occurring in the neck, and are the remains of the branchial clefts. They are of congenital origin, and are not contracted abscesses; they are not lined by granulation tissue, but by epithelium, and their non-closure is not due to any of the causes above enumerated, but to the epithelium which lines them and which prevents their closing unless it is removed. They will be considered in the sequel.

ULCERATION

Ulceration, as we have already stated, is really suppuration on the surface of the body, and the two processes, formation of acute abscess and ulceration, are pathologically identical, and the only difference is that the one takes place in a closed space, the other on a surface. We have seen that when an acute abscess is about to form, leucocytes first infiltrate the inflamed area, then destroy and replace the tissues of this area, and finally perish, and with the serum of the blood which has soaked in from surrounding tissues, form pus, which remains locked up, at all events for a time, in the cavity which has been formed by the destruction of tissue. So it is with ulceration: the inflamed area on the free surface is first infiltrated with leucocytes; then these leucocytes destroy and replace the tissues of the area, and finally they die and are thrown off superficially with a fluid, the serum of the blood, as pus. The surface which is left behind is a layer of tissue infiltrated with leucocytes, which have not yet completed the

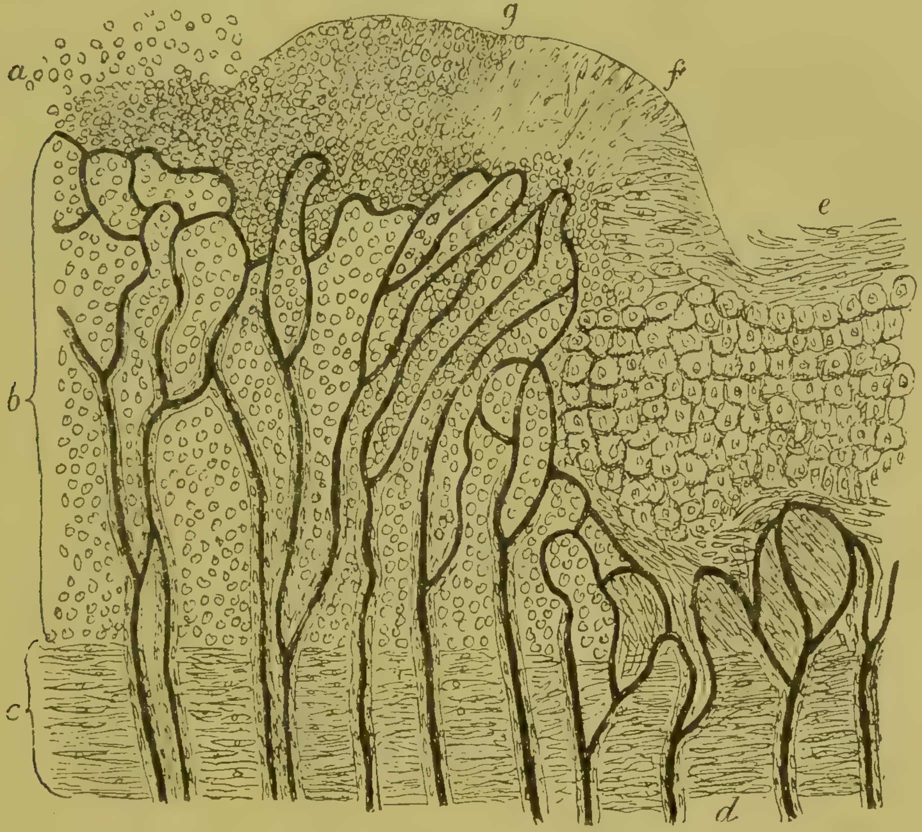

FIG. 26.—Vertical section through the edge of a granulating surface in process of repair (after Rindfleisch).

a, Pus cells; *b*, granulation tissue permeated by capillary loops; *c*, cells of granulation tissue becoming spindle-shaped; *d*, cicatricial tissue; *e*, epithelial cells proliferating and spreading over margin of ulcer; *f*, young epithelial cells; *g*, zone of differentiation.

destruction of the tissue, but are engaged in doing so; and is identical with the lining of an abscess cavity. Both suppuration and ulceration are inflammatory conditions. There is, however, a process which is termed ulceration, which is not inflammatory, where the same process is going on, but where the invading cells which destroy and replace the normal tissue are not leucocytes, but another variety of cells. This is the so-called ulceration of malignant tumours, where the special cells of the malignant growth enact the rôle of the leucocytes, and invade and destroy the normal tissues. It would save confusion if some other name could be adopted for this process, which is clearly not inflammatory.

The **pathology** of ulceration is therefore briefly as follows: Inflammation is set up on the surface of the body, and is attended by emigration of leucocytes; these leucocytes infiltrate the inflamed area; they destroy the tissues of this area and get rid of them; then they perish, and are thrown off and disappear. And by a spread of the inflammation and continuance of this process the ulcer increases in depth and extent. But the time comes when the cause of the inflammation is removed; the circulation in the surrounding vessels recovers itself, and the emigration of the leucocytes ceases. Repair now commences, and the process by which it takes place is identical with the process of union of wounds by granulation, already described. Loops of capillary blood-vessels permeate the deeper layers of the infiltrated tissues forming the base of the ulcer, and thus granulations are formed, consisting of the round cells of the infiltrated tissue enclosing and surrounding each capillary loop. At the same time the cells of the superficial layers of the infiltrated tissue degenerate, die, and are cast off. The surface of the ulcer is now covered with a layer of granulations (fig. 26), and under healthy conditions these undergo developmental changes, and are converted into scar tissue by the process already described in speaking of the union of wounds by second intention. Finally, epithelium forms over the scar by extension of the epithelium from its margin.

Causes.—The causes of ulceration may be considered under the two heads of (1) General and (2) Local causes.

1. The **general** causes are those which produce such a condition of tissue as to render it liable to be affected by ulceration, and they may be summed up under the one head of impairment of vitality—anything which impairs the vitality of a part by interfering with its nutrition, or otherwise, renders it liable to take on the process of ulceration, or, in other words, acts as a predisposing cause of ulceration. Accordingly we find that old people are more prone to suffer from ulceration than those of adult life, because the circulation is less active and nutrition is impaired, so that any slight exciting cause may induce this condition. Again, deficient innervation, as in cases where parts of the body are paralysed, by interfering with their nutrition, is a predisposing cause of ulceration, which may be excited by a very slight cause, as the pressure of the nates on the bed in bedsores. Thirdly, certain diseases, by inducing malnutrition of the body generally, may act as predisposing causes of ulceration; such diseases as diabetes and scurvy are exceedingly prone to be attended by the formation of ulcers from very slight exciting causes.

2. The **local** causes are generally due to one of two conditions: either (1) interference with the circulation of a part; or (2) some irritation applied to a part. (1) The interference with the circulation may be due either to a fault in the arteries, veins, or capillaries. Perhaps the best example of this is a varicose ulcer, which is due to the interference with the return of venous blood from the part owing to the varicose condition of the veins, and the incompetency of their valves. This leads to loss of nutrition, which results in ulceration. But the arteries may also be at fault. Atheromatous arteries, by preventing a sufficient supply of blood to a part and so impairing its nutrition, are very apt to give rise to ulceration. The manner in which the capillaries take part in the causation of ulceration is by pressure on them from without, which interferes so much with the circulation through them as to lead to the formation of ulceration. (2) Irritation of an inflamed part may cause ulceration. Thus,

the very dressings applied by the surgeon may cause it; either from the irritating nature of the application, or the mechanical injury which it does; or the irritation which produces the ulceration may be due to the septic condition of the discharge from a wound; or finally some specific infective organism may be introduced into a wound and set up ulceration, as in phagedæna.

Ulcers may be divided for purposes of description into two classes: (1) Those which are due to some cause which interferes with the nutrition of a part and not to any specific virus; these may be termed the *non-infective ulcers*; (2) Those which are due to some specific virus, and these are termed the *infective ulcers*. Only the former of these two divisions will be considered in this place. The latter will be considered in connection with the disease, syphilis, tuberculosis, &c., of which they are an outward manifestation.

Non-infective ulcers.—The non-infective ulcers are divided by Paget into three different classes: (1) The simple ulcer, which is the type of the disease; (2) Ulcers depending on constitutional causes; (3) Ulcers depending on local conditions. It will be sufficient if we consider the principal varieties of ulcers met with, without any attempt at classification.

1. **The simple or healing ulcer** arises from loss of substance due to accident, or to some pre-existing, but now past, condition. It is generally round or oval in shape, regular in outline, the edges are slightly shelving and present an opaque white zone of newly formed epidermis, within which is a second zone of a bluish colour where the epidermis is in process of formation. The surface of the sore is slightly depressed and covered with small red granulations, which do not easily bleed. The tissues around are slightly hyperæmic.

Treatment.—The treatment of a simple ulcer should aim more at protection and avoidance of irritation than anything else, and should therefore be as simple as possible. The sore may be covered with boracic acid ointment spread on muslin, or with a piece of lint soaked in boracic acid lotion and covered with oil silk: a layer of salicylic wool is then applied and the whole bandaged, so as to make uniform pressure. The dressing must be reapplied at least once a day.

Where the ulcer is large, and especially where it is on the lower extremity, skin grafting should always be resorted to, so as to obtain a sound scar, which will not break down again directly the patient begins to walk, and which will not show the same tendency to contract as the scar formed entirely by the cicatrisation of granulations. The first method of skin grafting was introduced by Reverdin of Geneva, and consisted of transplanting into the granulations small pieces of little more than epidermis, cut from some other part of the body. Here they form little islands of epidermal tissue, from which cicatrisation spreads. Therefore this process goes on not only from the margin of the sore, as it would do under ordinary circumstances, but also from the points of grafting on its surface. The healing process is therefore much hastened. This mode of proceeding has now almost entirely been superseded by Thiersch's plan, which aims at transplanting much larger and thicker pieces of skin, which produce a sounder scar, with less tendency to contract. By M. Thiersch's method at least half the thickness of the skin is transplanted in as large pieces as can be obtained, and the whole surface of the sore is covered. The mode of proceeding is as follows: The condition of the ulcer must first be attended to; it must be rendered perfectly aseptic, and must be treated until it possesses the characteristics of the simple, healing ulcer just described. This having been done, the patient is prepared for the operation by carefully sterilising the skin, which is to be used for the grafts, some hours before, and then dressing it with antiseptic gauze wrung out in 1 in 40 carbolic lotion. The most convenient situation from which to obtain the grafts is the front of the thigh; they can be more easily cut of large size in this situation than any other, and should any little scarring be left, it will not matter when in this situation. After the patient has been anæsthetised, all the granulations are carefully scraped away, so that a smooth firm base is obtained for the grafts. The granulations are very vascular and bleed freely, but all hæmorrhage must be entirely arrested before the grafts are applied. This can be done by placing over the surface a piece of sterilised green protective which has been previously dipped in a normal saline solution: this is covered with a thick layer of cotton wool and firmly bandaged on with uniform pressure. In a few minutes the bleeding will be stopped. The object of the protective is to prevent sticking on removal. The grafts must now be cut. The skin of the thigh is put on the stretch both vertically and horizontally, and the surgeon shaves off as large pieces as he can with a broad razor, endeavouring as far as possible to remove about half the thickness of the skin: these are at once transferred on the razor to the rawed surface, teased off with a probe, and so arranged that they shall cover the whole surface, with their margins slightly overlapping. The proceeding is much facilitated by keeping the razor constantly wet with normal saline solution. When the whole surface is covered with grafts it is to be dressed by placing over them a piece of green protective which has been well soaked in carbolic acid lotion, and has then been dipped, just before it is applied, in normal saline solution. This solution is not so irritating as the carbolic acid. Over this is placed cyanide gauze and wool, and the whole firmly bandaged. If the ulcer is on one of the extremities it is advisable to apply a splint, or place the limb between sandbags to insure perfect rest. This dressing may be left on for four or five days, and should then be removed and a fresh dressing applied. The surface from which the grafts have been taken should be dressed with a little boracic ointment and will heal in a few days.

Grafting of the *whole thickness* of the skin is sometimes employed, and for this the skin of the prepuce after the operation of circumcision can frequently be utilised, and is especially useful, as it is entirely devoid of fat, a circumstance which is absolutely essential to the success of the operation. The proceeding does not, however, appear to be so successful as the plan advocated by Thiersch.

2. **The inflamed ulcer.**—An ulcer may at any time become the seat of increased inflammation as the result probably of some septic infection, or, it may be, from some mechanical or chemical injury. There is then acute pain, heat, redness, and œdematous swelling of the surrounding skin. The edges are abrupt, sharply cut and irregular. The base of the sore is unhealthy looking, without granulations, and presents a sloughy appearance. The discharge is thick and blood-stained. Sometimes the inflammatory condition is so acute, that masses of tissue are killed outright by the intensity of the process, and the surface of the sore becomes more or less covered by pieces of gangrenous tissue. In this way considerable destruction of this tissue may take place, and the underlying muscles, vessels, and bones be exposed (fig. 27). To this condition the term *sloughing ulcer* is given, and it may be regarded as a sort of intermediate condition between ulceration and gangrene, but belongs more to the latter condition.

Treatment.—The treatment consists in elevating the limb, so as to facilitate the return of venous blood, and keeping it at perfect rest, and in the application of warmth and moisture to the part. The best way to do this is to apply a boracic acid poultice;—a double thickness of boracic lint, sufficiently large to cover the sore and the inflamed tissue around, is steeped for a minute or two in hot boracic lotion, and is then immediately applied to the part and covered with oil silk or jaconet to retain the heat and moisture. This should be changed every six hours. A brisk purge is also usually indicated.

3. The **weak ulcer** is characterised by pale, flabby, unhealthy granulations. It generally occurs where there is some defective nutrition of the part, either from some obstruction to the circulation or deficient quality in the blood from some constitutional condition. A simple ulcer may, however, become 'weak' from the too long continued application of emollient lotions. The edges lose the characteristic healing line, and become pale and flat. The surface of the sore is covered with large, semi-transparent, œdematous looking granulations, which readily perish. The discharge is thin and scanty. The **treatment** must be of a stimulating character. The application of a lotion of sulphate of copper or sulphate of zinc, with elevation of the part so as to favour the return of venous blood, is generally followed by satisfactory results. The lotion which I have found most useful in these cases is the red wash of the St. George's Hospital Pharmacopœia: Copper sulphate and Armenian bole, of each 15 grains; camphor, 5 grains; and boiling water, 5 ounces.

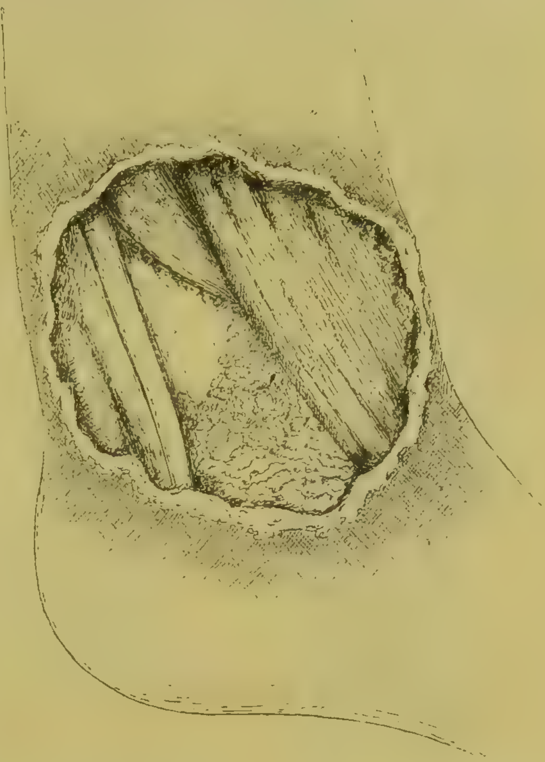

Fig. 27.—Drawing showing the ravages of a sloughing ulcer of the leg, after the sloughs have separated. (From the Museum of St. George's Hospital.)

4. The **exuberant ulcer**.—This is the form of ulcer which one usually meets with after the sloughs are separated in burns, and arises where there is some interference with the contraction of the sore, impeding the circulation. It is characterised by large, flabby red granulations, which project from the ulcer and give it a velvety appearance. They bleed easily, even from the slight mechanical violence employed in removing the dressing or from a slight touch of the finger. It may be mentioned in passing, that the characteristic of healthy granulations is that they should bear the tap of the finger without bleeding. These florid, red granulations are popularly known as 'proud flesh.'

Treatment.—The treatment consists in repressing the granulations by nitrate of silver and dressing the part with some stimulating application, as the red wash. The caustic only requires applying occasionally, i.e. every third or fourth day, and there is no necessity to apply it to the whole surface of the sore ; a belt half an inch broad around the margin is all that is necessary.

5. The **indolent or callous ulcer** (fig. 28).—This is the form of ulcer which is seen so often in the out-patient department of our hospitals, and is characterised as a 'bad leg.' It is always chronic and almost always situated on the leg at the junction of the middle and lower third. It is most commonly associated with varicose veins, and its chronicity depends upon the conditions arising from impediment to the venous return. The tissues around are thickened and indurated, very often pigmented: the borders are sharply cut, hard, irregular, and devoid of the ring of new epidermal tissue which surrounds a healing ulcer. The surface of the sore is pale, covered with a greenish-yellow semi-transparent layer, through which peep out here and there little islands of granulations. The secretion is thin, often offensive, and slight in amount. They are usually insensitive, but sometimes intense pain is complained of. This may be due to the exposure of a nerve ending on the surface of the sore; and if so, it will be found that the pain is acutely felt at one spot.

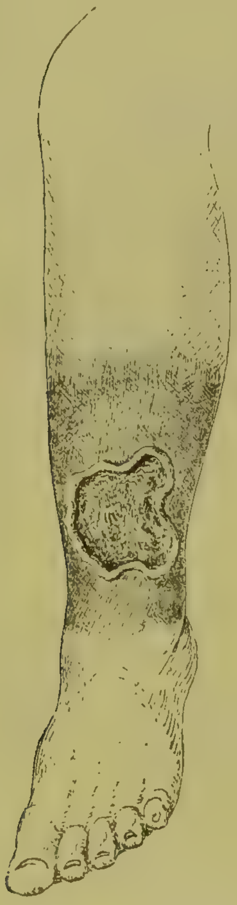
FIG. 28.—An old indolent or callous ulcer of the leg.

Treatment.—The treatment of the callous or indolent ulcer is often a difficult problem, since it mostly occurs in the poor, who are unable to give the time necessary for the thorough healing of the sore. When the patient can be treated in hospital, constant rest in bed, with elevation of the limb, will generally succeed in getting rid of the hard, callous edges, and in covering the surface of the sore with granulations, which after a time will cicatrise under the application of some stimulating lotion. But as soon as the patient begins to get about again, the cicatrix will break down, and the ulcer will be as bad as ever. It is therefore necessary as soon as the sore presents a healthy appearance, and the induration around has disappeared, to apply skin grafts, in order to obtain a covering for the sore which is not likely to give way. The absorption of the indurated tissue may be promoted by blistering around the scar or by pressure, which can be made with a Martin's bandage or by strapping.

If, however, the patient cannot afford the time requisite for this treatment, then an endeavour must first be made to promote the absorption of the chronic inflammatory products with which the surrounding tissues are infiltrated, for until this is done, there is no prospect of healing the sore. This can best be done by pressure, either by strapping or a Martin's bandage. The mode of applying the strapping is as follows: The limb is first thoroughly cleaned and shaved. The surface of the sore is powdered with iodoform and covered with a piece of green protective the size of the sore. Strips of soap plaister are then applied to the limb, beginning some inches below the level of the sore and continuing them upwards for some inches above. Each strip is rendered adhesive by dipping in hot carbolic lotion, and is then applied with its centre to the opposite surface to that on which the sore is, and the ends crossed over the ulcer. Each succeeding strip should overlap the one previously applied. A small hole should be cut in the strapping at the most dependent part of the sore, so as to allow the discharge to escape. The whole is then covered with a bandage. The strapping should be removed every other day, or every day if the discharge is considerable. Another plan of applying pressure is by means of Martin's bandage. The sore is covered with a piece of lint soaked in some antiseptic solution (carbolic acid lotion 1 in 40)—not with ointment which will destroy the bandage—and a piece of waterproof material applied over it. The limb is then evenly bandaged with a Martin's bandage, which should be perforated, to allow of the evaporation of the perspiration. The dressing should be applied each day before the leg is put to the ground, and care should be taken not to apply it too tightly. Unna of Hamburg recommends a plan which does away with the necessity and consequent expense of Martin's bandage. After cleaning the sore and applying iodoform, he uses an ordinary bandage, which he stiffens with a paste, composed of gelatine, glycerine, oxide of zinc and water, painted over the bandage. This can easily be removed by soaking the limb in hot water, which melts the gelatine, and the dressing can be renewed every day.

6. The **irritable ulcer.**—Some apply this term to any ulcer which is intensely painful, but it seems better to restrict it to one particular form of painful ulcer, which generally occurs in women, and is associated with some disorder of the uterine functions. It occurs usually in neurotic women about the period of the menopause, and its favourite seat is just behind one or other malleolus. It is generally small, with somewhat raised edges and a punched-out appearance, and is exquisitely painful, often preventing sleep at night, and wearing out the patient's strength.

Treatment.—The most satisfactory treatment is to destroy the whole of the surface of the sore, and this may be done by rubbing it over with a stick of lunar caustic, or, what is better, swabbing it over with a solution of chloride of zinc (gr. xl to ℥i). A warm boracic poultice should then be applied till the superficial slough separates. At the same time attention must be paid to the uterine condition.

7. The **eczematous ulcer** is an ulcer where the surrounding skin is the seat of eczema, and it may be that the ulcer is the result of the eczema; but what is more common is that the ulcer existed first, and that the eczema is the result of the too long continued application of a warm, moist dressing. It is especially liable to occur under these circumstances in ulcers associated with varicose veins, where the circulation in the part is defective. The skin around the ulcer presents a red, shining, glazed, or raw appearance, and there is abundant thin, acrid discharge with an alkaline reaction. The discharge is liable to dry, and forms yellowish crusts.

Treatment.—All moist applications must be left off, and the part dusted with oxide of zinc or boracic acid; or these remedies may be applied in the form of ointment. The condition is often associated with a gouty diathesis, which must be treated. The administration of a little potassio-tartrate of soda and sulphur each morning is often very beneficial.

8. The **varicose ulcer** is the ulcer arising from or dependent upon a varicose state of the veins of the leg (see fig. 115). It generally occurs at

about the junction of the middle and lower third, because here there is very little communication between the superficial and deep veins; whilst lower down, that is to say around the ankle joint, the communication between the superficial and deep veins is free, and the surplus blood is carried away by the latter vessels. In consequence of the impediment to the return of the venous blood from the incompetency of the valves in the varicose veins, these parts become involved in a condition of passive congestion, resulting in induration. Any slight injury or abrasion of the tissues, instead of healing as it ordinarily does in healthy tissues, starts the ulceration, which is continued on account of the defective circulation, and speedily results in the formation of a callous ulcer. One serious complication may occur in these cases: the ulcerative process may extend into one of the dilated veins, and a very considerable loss of blood may result.

Treatment.—These ulcers must be treated on the lines laid down for the treatment of the indolent or callous ulcer; and when healing has taken place, attention must be directed to the treatment of the cause of the condition, viz. the varicose veins. This will be referred to in the section dealing with injuries and diseases of blood-vessels.

9. The **hæmorrhagic ulcer.**—Under the head of hæmorrhagic ulcer are included two distinct classes of cases. (1) We occasionally meet with an ulcer which is often of inconsiderable size, but in which the tissues around are swollen and of a dusky red hue, whose great characteristic is that it is constantly bleeding. The slightest injury or even the rough removal of the dressings will cause it to bleed. These ulcers are generally found in persons suffering from scurvy, and are therefore sometimes termed 'scorbutic ulcers.' (2) The other form is comparatively rare, but of considerable interest. The ulcer presents nothing of special note, and the only peculiarity about it is that at intervals a discharge of blood takes place from its surface and continues for some days, and then spontaneously ceases, only to recur at regular or irregular intervals. These are believed to be cases of vicarious menstruation. I have only had an opportunity of seeing one such case, which occurred in St. George's Hospital under the care of the late Mr. Pollock. It was in a young girl, aged about 20, who had a small punched-out ulcer on the outer side of one leg. There was nothing peculiar about the appearance of the ulcer, but it refused to heal, and, as she stated, regularly once a month a slight discharge of blood took place from its surface and continued to do so for five days and then spontaneously ceased. The patient had never menstruated, but otherwise was apparently healthy. The patient was retained in the hospital for some months, and the accuracy of her statement verified. She was then discharged and lost sight of.

10. The **phagedænic ulcer** is an ulcer which is probably due to some specific infection. The disease shows itself both in an ulcerative and a gangrenous form. The description of it will therefore be postponed till we come to speak of Gangrene.

GANGRENE

By **Gangrene** is understood the death of a visible portion of the soft parts; and the term is usually employed where the part that dies is of considerable size, as a limb or portion of a limb. When only a small portion of tissue dies, especially a small portion of the skin, we use the term *sloughing*, and the part which dies is called a *slough*. Many of these cases go by the name of sloughing ulcer, but they more properly belong to the condition of mortification than of ulceration, since there is always death of visible portions of tissue, which are thrown off as dead matter.

Gangrene is divided, according to its form, into moist or dry. The division is a classical one, and in extreme cases a very well marked one; but between these two extremes there are all sorts of gradations, so that ordinarily in practice it is very often difficult to refer the case to the one or the other form. It will be convenient, however, to describe a typical instance of these two forms in the first place, and then, taking the causes of gangrene as a classification, point out the various features in which the gangrene varies from these typical forms according to the cause which has given rise to it.

Dry gangrene is essentially a chronic process, and occurs in those cases where there is a deficiency of blood supply to the part, and where the fluids which are present, owing to the chronicity of the process, have time to evaporate. Moist gangrene, on the other hand, occurs where there is too much blood in the part, and where, owing to the greater acuteness of the process, the fluids contained in the part have not time to evaporate, and where therefore putrefaction takes place. In the dry form, owing to the absence of moisture, which is essential to the process of fermentation, the ordinary putrefactive changes do not take place or take place very slowly; the gangrenous parts simply become dry and mummified.

Dry gangrene.—The part affected becomes paler than natural, sometimes tallowy white and mottled with dusky spots. It becomes dry, shrivelled, and hard. Then the colour changes, and it turns to brown and eventually becomes quite black. The shrinking process continues and the skin becomes wrinkled, so that it assumes the appearance of a mummy. The surface of the part is greasy, from the fatty matters becoming liberated from the fat cells and infiltrating the tissues. There is usually very great pain in these cases, and this is believed to be due to the fact that the nerves are the last structures to die. Little or no putrefaction takes place, and therefore the offensive odour which is so characteristic of the moist form of gangrene and which arises from the gaseous products of putrefaction is not present. The process of death is a slow but progressive one, and the gangrene having commenced, generally at some point farthest removed from the central organ of the circulation, spreads slowly, sometimes for weeks and months, before it is arrested and a line of demarcation set up. And it frequently happens soon after a line of demarcation has been set up, that the process recommences, and the living tissues in the immediate neighbourhood of this line take on the same process of dry gangrene.

Moist gangrene occurs where there is an excess of blood in the part owing to some arrest in the circulation through it, and where therefore there is, first, an intense passive congestion before death actually takes place. Secondly, the vessels become so choked that an actual stoppage is the result: the fluid parts of the blood transude through the walls of the vessels, with a certain number of corpuscles both pale and coloured, and the part dies. Thirdly, the part being dead undergoes putrefaction. The **symptoms**, therefore, of moist gangrene may be considered in connection with these three conditions—passive congestion, death, and putrefaction. When a part is about to become the seat of moist gangrene, it becomes swollen, of a dusky red hue, the tissues become œdematous, pain of a burning character is complained of, and there is increased pain on touching or handling the part. After actual death has taken place, the gangrenous part becomes colder than natural, the colour changes to a dark greenish purple tint and then becomes black. All sensibility in the part itself is lost, so that it may be pricked with a needle without the patient experiencing any sensation of pain. Putrefaction now sets in; upon pressing the finger on the gangrenous tissues a sensation of crepitation is experienced from the evolution of gases—the products of decomposition—in the cellular tissue. Bloody bullæ form on the surface, and after a time the epidermis peels off (fig. 29). These symptoms are accompanied by a foul-smelling fœtid odour, which is also due to the presence of gases formed during the process.

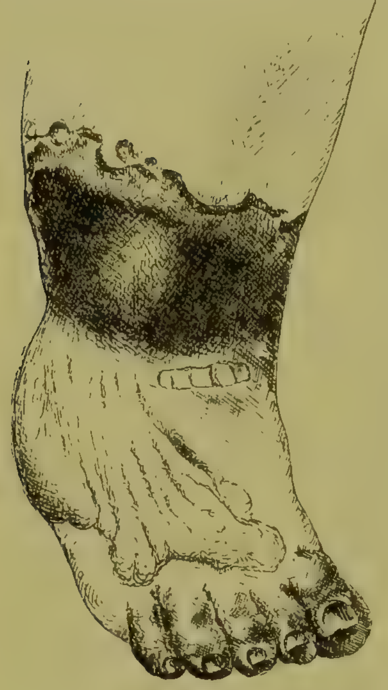

FIG. 29.—Moist gangrene in the leg of a child. (From a drawing in the Museum of St. George's Hospital.)

The patient suffers from fever of an asthenic type, due to the absorption of the poisonous products of decomposition.

Separation of dead tissue.—The dead portion of tissue, whether large or small; whether due to the dry or moist process of gangrene, must be got rid of, and this is accomplished by a process of ulceration in the living tissues in contact with the dead. Here inflammation is set up as the result of the irritation of the dead tissues. This is attended by diapedesis and infiltration with leucocytes of the layer of living tissue which joins the gangrenous parts. The leucocytes destroy and replace this layer of tissue, and in their turn are replaced by granulation tissue, which separates the living and the dead parts, formerly directly continuous with each other. This granulation tissue then undergoes a process of degeneration and is converted into pus, which flows away and leaves a gap or hiatus between the living and dead tissue; or, in other words, the one is separated from the other. This process begins on the surface, in the skin, where very soon a furrow forms as the granulation tissue is converted into pus, and the furrow deepens until the whole of the tissues, including the bone, if there is any that has died, are separated.

In cases where a limb or a part of a limb has perished, the deeper parts are separated at a lower level than the more superficial ones, so that the stump which is left is a conical one. The bone which forms the apex of the cone separates at a lower level than the other structures, the deeper muscles at a lower level than the more superficial ones, and the skin at the highest level of all. This surface, if the patient's reparative powers are good, may, under favourable circumstances, cicatrise in the same manner as an ordinary ulcer.

VARIETIES OF GANGRENE

Various forms of gangrene are met with and will have to be described. These are best classified by arranging them according to the cause which has given rise to the gangrene.

Causes of Gangrene.—The immediate cause of gangrene is the arrest or deficient supply of blood to a part, and this may be brought about in many different ways, which may be considered under three divisions: 1. Local causes. 2. General causes. 3. Specific causes.

1. **The local causes of gangrene** are (*a*) injuries, either mechanical or chemical; (*b*) heat and cold; (*c*) arrest of the circulation; (*d*) the intensity of an inflammation; and (*e*) the loss of nerve power.

(*a*) Under the head of **injuries** as a cause of gangrene we have, first, gangrene due to *crushing*.

We have already had an opportunity of seeing an example of this, in speaking of contused and lacerated wounds, in which it was stated that small fragments of tissue at the edges of the wound were so contused and crushed by the injury that they were no longer capable of living; they had had their vitality destroyed. It may be that these particles of tissue may be very small, but this is undoubtedly as much gangrene as if a whole limb were crushed between two millstones, and had its vitality crushed out of it; or, in other words, were so injured by the violence done to them that they were no longer capable of carrying on the functions of living tissues. In these cases merely the parts which are injured die, and there is no tendency on the part of the gangrene to spread. It must not be confounded with those cases of gangrene which arise from injury to the main vessels of the limb, when the arrest in the circulation comes about in another way. In these latter cases the gangrene commences in the part of the limb farthest from the heart and not at the seat of injury, and may spread some considerable distance up the limb, but rarely as high as the point where the vessels have been torn. The gangrene in those cases where it has been produced by crushing is of the moist kind, and is followed by putrefaction, with its attendant symptoms, unless care is taken to render and maintain the part aseptic.

Another form of mechanical violence which may produce gangrene is *pressure*, too severe or applied for too long a time. I have seen the whole thumb become gangrenous from the application of a Martin's bandage too tightly and too long retained on the part. So again the continued pressure of a splint, especially over a prominent process of bone; or even the pressure of the patient's body on the bed, if long continued on the same part, may produce gangrene. This latter variety is known as bedsore. In these cases also the gangrene is of the moist kind.

Chemical agencies combining with the animal matter and forming new compounds may produce gangrene. A good illustration of this is the effect of potassa fusa on the tissues in making an issue, where the skin is destroyed by the desiccating action of the caustic and forms a slough.

(*b*) **Heat and cold**, as we have already seen (p. 104), kill the tissues and produce gangrene.

(*c*) **Arrest of the circulation.**—Under this heading are included those cases where suspension in the capillaries is due to arrest in the arterial or venous circulation from gradual diminution in their calibre, as in calcification or atheroma in the arteries; or else from the sudden obstruction to the flow of blood through them from accident, ligature, thrombosis, or embolism. Gangrene due to gradual diminution in the calibre of the arteries is generally known under the name of *senile gangrene.* But in this form of gangrene the diminution of the calibre of the vessels is only one of the factors in the production of the disease; another and perhaps an equally important factor is a weak heart, whose propulsive power is not sufficient to drive the blood onwards through the vessels, especially in the lower limbs. In addition to this, senile gangrene has generally some exciting cause, in the form of inflammation induced by some slight injury, which throws an extra strain upon the enfeebled circulation. The cause of the gradual diminution in the calibre of the arteries is generally primary calcification, a senile change in the muscle cells of the middle coats of the arteries which converts them into rigid tubes. But it may also be due to atheroma, which when it affects the smaller vessels is especially apt to undergo secondary calcification, and appear as calcareous plates on the inner surface of the artery. These are liable to excite thrombosis. Whether they do or not, the lumen of the tube is much diminished from the irregular thickening, and the circulation of the blood interfered with.

Senile gangrene is, as its name implies, a disease of advanced life, rarely appearing before sixty, and it is much more common in the male than in the female.

This form of gangrene is usually ushered in by certain premonitory symptoms due to the defective supply of blood to the part. Thus, the patient complains of cold feet, which no amount of warmth seems to relieve. He also complains of all sorts of abnormal sensations, tinglings, or feeling of 'pins and needles;' a sensation of weight in the limbs; and frequently says that he feels as if he were walking on cotton wool. He suffers also from cramp, especially in the muscles of the calf. If under these circumstances the patient is examined, it will be found that the arteries are hard, rigid, and incompressible, and probably no pulsation will be felt in the tibials at the level of the ankle joint.

The actual advent of the disease is usually ushered in by some slight injury; the patient chafes his foot with an ill-fitting boot, or in paring his nails or a corn he inflicts a slight scratch. The part inflames, the skin around the little wound becomes of a dusky red hue, and in the centre of this there is a little black spot. Or the gangrene sets in without any apparent exciting cause, a toe becomes swollen, red and œdematous, and on the end of the toe a black spot appears. Occasionally the toe becomes black and shrivelled without any appearance of inflammation; but, as a rule, an inflamed area precedes the formation of the gangrenous spot. Once started, the condition slowly spreads. The black patch extends into the area of redness, and, as it does so, a fresh halo of inflammation appears. One of the great characteristics of the disease is the intense burning, smarting pain by which it is accompanied. In fact, it is the only thing of which the patient complains, and his general health does not, as a rule, suffer at first. After a time, as the disease progresses and the pain continues, he becomes worn out by it and by the want of sleep; he becomes weak and restless, with a feeble pulse, and dies exhausted. In addition to this, if great care is not observed in keeping the part aseptic, especially at the line of demarcation after it has formed, and where a suppurative process is going on, septic absorption may take place, and the patient develop fever of an asthenic type, with low muttering delirium, and this may hasten the end. The local trouble proceeds very slowly; one toe after another becomes involved, becoming black, dry, and mummified, and the disease may creep on to the foot and extend as far as the ankle joint, a favourite site for a line of demarcation to take place, corresponding to the point of bifurcation of the posterior tibial artery. When arrest takes place, supposing the patient survives long enough for it to occur, separation of the gangrenous parts commences (fig. 30), and eventually the dead parts may drop off, leaving a ragged irregular stump.

Treatment.—An important point in the treatment of senile gangrene is to render the part as aseptic as possible and keep it so. The foot should first be thoroughly cleaned by washing with soft soap; rubbed with turpentine to get rid of any greasy material, and then well sluiced with corrosive sublimate solution. Much of the patient's welfare depends upon this being thoroughly done, for if the parts are allowed to remain septic, irritative fever from septic absorption will be set up and the case assume a much graver aspect. After the foot has been well cleansed, it must be dressed with antiseptic dressings. Subsequent dressings must be done with as much care as in the dressing of an ordinary operation wound. In fact, the same antiseptic rules are to be as rigidly carried out in these cases as in any others. Opium is of the greatest service in the treatment of senile gangrene; it not only relieves the pain, but it allays the nervous irritability and enables the patient to bear the enforced rest. It must be given with care, so as not to upset the digestive organs, and a small dose two or three times a day will often be found more beneficial than one larger dose once a day, say at night. In order to enable the patient to take the opium, the diet must be carefully regulated. A nutritious, somewhat generous diet is required, but it must be given with discrimination; easily digestible articles of food must be selected, and the stomach not overloaded, but nourishment given in small quantities at frequent intervals. Soups, beef tea, fish, poultry or game, with perhaps a little

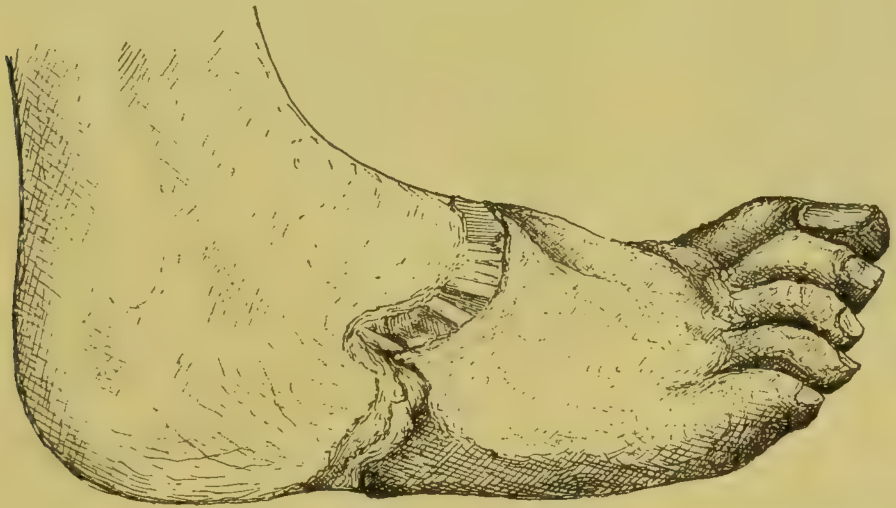

FIG. 30.—Dry gangrene of the foot from an embolic plug in the popliteal artery. The gangrenous parts are in process of separation. (From a preparation in the Museum of St. George's Hospital.)

boiled mutton occasionally; but beef, all highly seasoned food, hashes, curries, stews, &c., should be avoided. Then comes the question of stimulants. A little stimulant, in the shape of weak brandy or whisky and water, is no doubt required, but I am sure a great deal of harm is done by pushing stimulation too far. It increases the action of the heart, and excites it to drive more blood through vessels which are incompetent to carry the blood they have already to transmit, and therefore any amount of stimulant which excites the heart's action is prejudicial.

In cases of senile gangrene, a question of considerable importance as to the advisability or not of performing amputation cannot be said to be conclusively settled. Until within recent years surgeons abstained for the most part from recommending the removal of the limb in cases of senile gangrene, on account of the acute inflammation, followed by sloughing, which usually attacked the stump. This was due to septic causes, and nowadays with attention to antiseptic precautions may be avoided. There is therefore a greater tendency on the part of surgeons to advocate amputation, and also to advocate *early* operation, before the patient's strength has been lowered by the pain and want of sleep. The amputation has, however, to be done high up, for it is impossible to say where the gangrene will cease until a line of demarcation is set up, and even after this has taken place a fresh outbreak of the gangrene may take place above the line of demarcation. Therefore, amputation through the knee joint, or immediately above it, is usually recommended. Of these, the latter operation is probably to be preferred, as the flaps are better nourished, and there is less risk of sloughing. But there is something to be said, on the other side, against the routine practice of amputating early in these cases. Amputation in the lower third of the thigh is a serious measure for a gangrenous toe, which may continue for a long period, twelve months or more, without causing any great constitutional disturbance, slowly creeping on or undergoing arrest, and gradually separating. It is a serious measure, because such an operation cannot be performed on a man advanced in life, with rigid calcified arteries, and a feeble heart, and probably with his kidneys and other eliminatory organs in not as healthy a condition as they once were, without very considerable immediate risk of death from shock. And again, because of the feeble vitality of the tissues, the process of repair is very prolonged and imperfect, and the patient may sink from exhaustion. Moreover, in these cases, owing to the brittle nature of the vessels, the process of ligaturing them is attended with considerable difficulty, since the ligature, as soon as it is tightened, cuts through the vessel and will not hold. Torsion in these cases is out of the question. In one patient on whom I operated for senile gangrene, the difficulty I had in commanding the hæmorrhage was so great, that I had to resort to the actual cautery before I could control it. Personally, therefore, I cannot say that I recommend the routine practice of high amputation in the early stage of senile gangrene. I think that each case should be treated on its merits, and before deciding on amputation, attention should be directed to the rate of progress of the gangrene, the amount of pain suffered, the general state of health of the patient, and the condition of his eliminatory organs.

Sudden obstruction of the flow of blood through the vessels producing gangrene may be caused by (α) accident, (β) ligature, (γ) embolism, or (δ) by strangulation.

(α) Under the head of **accident** we include all those cases where the damage to the great vessels of a limb is so great as to intercept the circulation through them. This may be caused by a wound of the soft parts which severs the artery; or by a fracture, the broken end of the bone lacerating the artery; or by the broken end of a bone pressing upon an artery without lacerating it, but preventing by its pressure the blood from reaching the parts below; or it may be caused by subcutaneous laceration of the main artery of the limb through some sudden strain; this most frequently occurs in the popliteal and axillary arteries.

(β) **Ligature** of an artery rarely, if ever, produces gangrene, unless there is some complication. The collateral circulation is nearly always sufficient to carry on the circulation sufficiently to preserve the vitality of the limb. It is said that ligature of the third portion of the axillary artery is more likely to be followed by gangrene than any other vessel on account of the small amount of collateral circulation. When gangrene does occur after ligature it is generally due to thrombosis of the vein, resulting either from some injury done to it during the operation; or from the loss of the vis a tergo, or propulsive power which is mainly instrumental in promoting the circulation through the veins. When the main artery is tied this propulsive power is lost, and the blood becoming stagnant may coagulate and form a clot in the vein, and under these circumstances gangrene is very liable to occur. In these cases the gangrene is of the moist variety, whereas when it occurs as the result of ligature, as an uncomplicated condition, it is of the dry kind.

(γ) **Embolism** is an occasional cause of gangrene. An embolus is a solid body, generally a vegetation from one of the valves of the left side of the heart, or a portion of fibrin from an aneurism, which has become loosened, and is carried along in the current of the blood through the arteries until it becomes lodged in a vessel too small to allow of its passage. This lodgment usually occurs at the point of bifurcation or where some large branch is given off, so that the artery becomes suddenly smaller. The embolus thus corks up the vessel and entirely prevents the passage of blood through it (fig. 31). A thrombus forms on the top of the clot up to the first collateral branch.

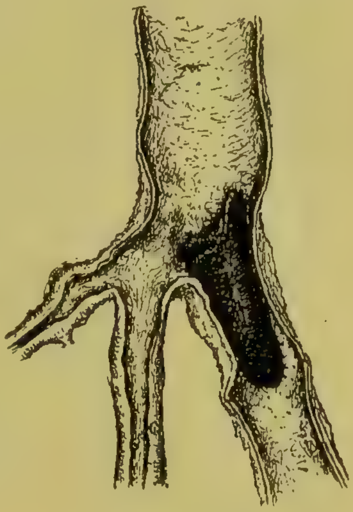

FIG. 31.—An embolic clot, lodged in and completely obstructing the superficial femoral artery. (From a patient who was admitted with diseased heart and dropsy, and in whom gangrene of the foot subsequently supervened. St. George's Hospital Museum.)

When a limb is thus suddenly deprived of blood by the division or laceration of its main artery; by a ligature of the artery, when it is not complicated by thrombosis of the vein; or by an embolus becoming lodged in it, the limb becomes cold and white, and all pulsation in the vessels below the seat of injury is lost. If the collateral circulation is established, it soon recovers its colour and warmth; if not, it falls into a condition of gangrene. It becomes colder, feels heavy, and all sensibility becomes lost; the whiteness becomes mottled with brownish streaks, then becomes black and shrivelled, and presents all the characteristics of dry gangrene. Gangrene from these causes occurs much more frequently in the lower than the upper extremity, and the extent of the gangrene will depend upon the seat of the lesion in the artery, though it does not necessarily extend up to this point. For instance, if the lesion is in the superficial femoral, the gangrene will not extend higher than the upper part of the leg, because the branches of the profunda are sufficient to supply the whole of the thigh; usually it does not extend higher than the level of the ankle. A case recently under my care in St. George's Hospital illustrates this point. It is that of a young man, aged 20, who was admitted into hospital for rheumatic fever and endocarditis. A day or two after admission he was seized with intense pain in the foot, and it became cold and white. Gangrene set in and was limited to the sole of the foot, and did not implicate the toes or the dorsum of the foot. After amputation an embolus was found at the bifurcation of the posterior tibial, which completely occluded the artery at this point. No doubt the reason why the toes were not involved was because of the anastomosis of the digital branches of the dorsalis pedis with those of the plantar arteries.

The only point in connection with the treatment of these cases to which allusion need be made is the question of amputation. In all other respects the treatment is that of any other case of gangrene. In these cases it is necessary before resorting to amputation to wait until an arrest of the process takes place, and this for two reasons: in the first place, the surgeon can never know how much of the limb will perish, and if he amputated at once he might remove too much; and secondly, by delaying the operation he gives the collateral circulation an opportunity of establishing itself, and thus does away with the chance of sloughing taking place in his flaps.

(δ) Mention must be made of another way in which gangrene is induced by an arrest of the circulation, and this is by **strangulation**. This strangulation may be sudden and complete, or gradual and incomplete. Sudden and complete strangulation is sometimes practised by the surgeon as a remedial agent, as in the strangulation of a pile or nævus. The part is encircled with a ligature, which is tied as tightly as possible, so that all circulation through it is arrested, and the part becomes gangrenous and separates from the living tissues. Incomplete strangulation is generally accidental, and is well exemplified in a strangulated hernia. Here a portion of gut is nipped by the ring through which it passes, and is partially strangled, the veins being principally involved, so that some blood finds its way into the strangulated piece of intestine, but none can get out. The part swells, turns black, the vessels become choked, stagnation takes place, and the gut eventually dies if the constriction is not removed.

(*d*) **Inflammation as a cause of gangrene.**—In speaking of *inflammation* it has already been stated that this condition may end in gangrene. It may be that the irritant which produced the inflammation is so intense that it causes stasis in the vessels, and this, if not relieved, will result in gangrene. But a great deal depends in these cases upon the tissues which are the seat of the inflammation. Some tissues, which are not very vascular, as areolar tissue and fasciæ, are much more apt to die than other more vascular tissues, as muscle or skin. Again, tissues which are degenerated, as in old people or in the intemperate, are more likely to fall into gangrene, if they become inflamed, than the tissues of the robust and vigorous. The gangrene which follows inflammation is always of the moist kind, and is generally attended with fever of an asthenic type, due to septic poisoning.

(*e*) **Gangrene due to loss of nerve power.**—Loss of nerve power is sometimes a cause of gangrene. When a limb is paralysed, its nutrition is deficient, and in some cases a part deprived of its nerve stimulus may actually fall into a condition of gangrene. We see this in cases of injury to the fifth pair of cranial nerves, which is frequently followed by sloughing of the cornea. This part is supplied with sensation by the fifth nerve, and when this nerve is paralysed, its nutrition is impaired and it dies. Several explanations of the cause of this have been given. One is that the division of the nerve destroys the vaso-motor filaments which supply the muscular coat of the arteries, which becomes paralysed and the vessels permanently dilated. But permanent dilatation produced by division of the sympathetic does not cause paralysis, and it is therefore difficult to understand why it should do so in division of the cerebro-spinal nerves. Again, it is said that it is due to loss of nutrition from destruction of the trophic nerves. The most probable explanation is that of Mr. Hutchinson, viz.: that it is due to a condition of spasm of the muscular coat of the blood-vessels, brought about by a reflex irritation of a sensory nerve. The gangrene which is produced in this way is of the dry kind, and is very insidious, coming on and spreading slowly. The part becomes cold and shrivelled, and is quite insensitive: the skin becomes smooth, shining, and glistening, and the papillæ waste away and disappear. Gradually the colour, which was in the first instance dusky red, turns to purple and then black, and the part becomes gangrenous, without any fœtor and without any constitutional disturbance, at all events until the process of separation commences. This condition is almost always seen in the fingers and toes, and is especially liable to occur in the little finger after injury to the ulnar nerve. In addition to this gangrene which is the direct outcome of defective innervation, we have a large number of cases where the gangrene is produced indirectly by imperfect innervation from pressure or some such cause. To this class belong another group of bedsores differing from those already spoken of. They are generally of the moist variety of gangrene, come on quickly, run a rapid course, and are often spoken of as *acute* bedsores. They occur when any paralysed part is subjected to pressure: as the back of the sacrum from the pressure of the body on the bed in a person who is paralysed, and a sore produced by the pressure of a splint applied to a paralysed limb, and would appear to result from imperfect nutrition of the paralysed tissues.

2. **General causes of gangrene.**—Under the heading of general causes producing gangrene, there are four different varieties which will have to be considered: (*a*) symmetrical gangrene, or Raynaud's disease; (*b*) gangrene in connection with diabetes; (*c*) gangrene following the use of ergot of rye; and (*d*) gangrene after acute fevers.

(*a*) **Symmetrical gangrene.**—It will be convenient first of all to consider symmetrical gangrene, because, like that form of gangrene we have just been considering, it is connected with nervous derangement. It was first described by Raynaud under the name of 'La gangrène symétrique des extrémités,' and, as its name implies, it comes on symmetrically in the two extremities. It may also occur in the external ear. It much more frequently attacks the upper than the lower extremity, and generally occurs in young women between the age of eighteen and thirty, but it is also seen occasionally in young children. It occurs most frequently in the weak and anæmic, who habitually suffer from cold extremities, and is generally brought on by cold weather. It is supposed to be due to spasm of the arterioles, but the pathology of the disease is uncertain. Upon post-mortem examination, no changes have been found in the vessels, which are apparently healthy. Many of the cases occur in neurotic females, who suffer from uterine troubles, and therefore it has been believed that the spasm is due to reflex irritation from the uterine condition; but that this cannot be the sole cause is evidenced by the fact that it occurs in young children and in boys. It shows itself in three stages, which have been named respectively, local syncope; local asphyxia; and gangrene.

In the first stage, *local syncope*, the part, generally one or more fingers, becomes perfectly white and very cold. It 'feels dead,' and is quite insensitive to the prick of a needle. This may last a few minutes, or may continue for an hour or two and then pass off, or it may pass into the second stage, *local asphyxia*, when the fingers first become swollen and red, then more and more dusky, and finally black. This condition may last for a day or more, and then pass off and leave the part exactly as it was before the attack. It may be repeated at longer or shorter intervals. Or, on the other hand, this local asphyxia may continue and terminate in the third stage, *gangrene*; bullæ form on the surface, and a dry slough slowly forms and separates, generally not extending deeper than the skin (fig. 32). The ulcers which result are sluggish and slow to heal. The treatment must consist in improving the general health, and preparations of iron are especially indicated. Any uterine irregularity, if it exists, should be corrected. Warm woollen gloves should be constantly worn, and care taken not to expose anyone liable to this disease to any great cold. Raynaud advised the constant current, and this or placing the part in an electric bath is stated by some to have been followed by beneficial results. If the disease runs on to gangrene, it must be treated on general principles, with a view to maintaining asepticity of the part.

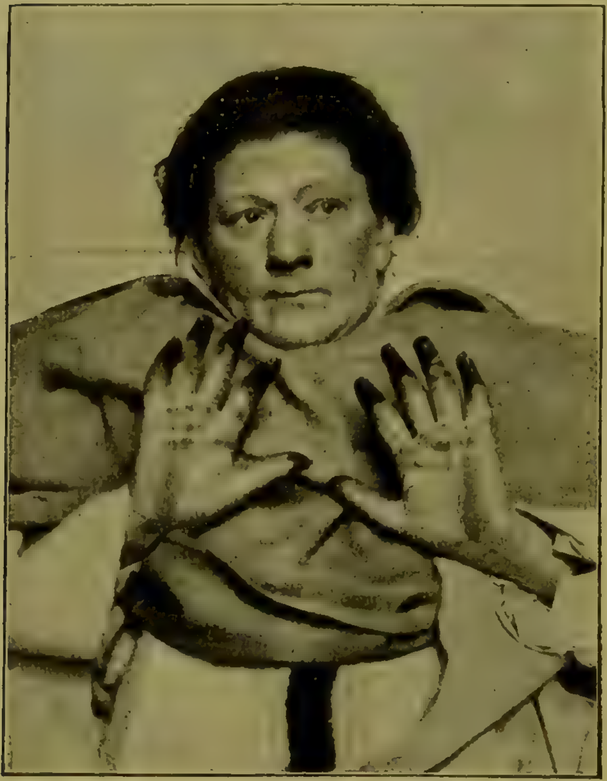

FIG. 32.—A case of Raynaud's disease or symmetrical gangrene. (From a photograph in the Museum of St. George's Hospital.)

(*b*) **Gangrene in diabetes.**—Gangrene is very liable to occur in the diabetic subject, and usually occurs during middle life. There would appear to be several causes which conduce to the production of gangrene in these cases, but undoubtedly the most important is the changes which take place in the vessels themselves. In consequence of the irritation which is induced by the presence of the sugar in the blood, a chronic endarteritis is set up and produces extensive arterial degeneration, the vessels becoming thickened and roughened ; and therefore as regards this element in its causation, diabetic resembles senile gangrene. But there are believed to be other elements at work. Changes in the nervous system due to diabetes assist in causing the disease ; sometimes this is a peripheral neuritis ; in others, innervation from the central nervous disturbance. Moreover, diabetes is associated with a general malnutrition of the tissues, and they are therefore unable to recover from injury or resist the invasion of microbes.

Diabetic gangrene is characterised by the large amount of inflammation of surrounding tissues which attends it, and by the rapidity with which it spreads. It is of the moist kind and resembles to a certain degree cellulitis ; that is to say, a slight wound in a diabetic subject is often followed by a rapidly spreading inflammation, which speedily runs into gangrene. There is generally a considerable amount of fever of a low type, and the case usually terminates fatally from asthenia or diabetic coma.

Treatment.—An essential feature in the treatment of this disease is the preventive treatment. Any person who is the subject of diabetes should be careful to avoid all starchy foods and sugar. The dieting of diabetic patients belongs more, however, to medicine than surgery, and need not be more fully discussed in this place. At the same time the diabetic patient should be cautioned to avoid anything likely to cause injury, which is often the exciting cause of this disease. When the gangrene has actually set in, the question of amputation is one of paramount importance, and the remarks which were made upon amputation in senile gangrene apply equally to these cases, but with this essential difference, that whereas senile gangrene runs a very slow course and the patient may remain for a year or more without developing any grave constitutional disturbance, in diabetic gangrene the disease runs a very rapid course, and terminates, in most cases, fatally in a very short space of time, so that amputation appears to be much more indicated in this latter disease than in senile gangrene. It is true that the operation, even in these antiseptic days, is one of considerable risk ; but if strict asepsis is maintained, septic inflammation of the stump is avoided, and the other danger, viz. diabetic coma, is probably as likely to occur if amputation is not performed as if it is. The amputation must be done high up, for fear of a return of the gangrene in the stump.

(*c*) **Gangrene following the use of ergot of rye.**—This disease occurs in districts where rye bread is eaten, but it would appear not to be due to the rye when it is healthy, but to a diseased condition which sometimes appears in certain districts. This form of gangrene is epidemic and endemic, and indeed seems sometimes to affect a single family or group of families where diseased rye has been used in the manufacture of their bread. It is due to a continued spasmodic contraction of the muscular coats of the smaller arteries, which narrows their calibre and diminishes the supply of blood to the part. The disease is almost unknown in modern surgery, and appears to have been formerly more common in some parts of the Continent than it was in this country. The gangrene is of the dry variety, and is preceded by diarrhœa, cramps, and coldness of the extremities.

(*d*) **Gangrene after acute fevers.**—Gangrene sometimes occurs during convalescence from some of the acute fevers, scarlet fever, typhoid, and typhus, and is due to endarteritis and embolism. It is of the dry variety, and affects those parts of the body which are most distant from the central organ of the circulation, namely, the toes and the fingers.

Before we proceed to speak of the specific forms of gangrene, that is to say, those forms of gangrene which arise from a specific cause, it will be advisable to say a word or two upon the treatment of gangrene in general, in order to supplement what has been already said upon the special treatment of the various kinds of gangrene which we have been considering.

Treatment of gangrene.—The treatment of gangrene may be summed up as follows: remove the cause if possible; if this cannot be done, endeavour to prevent the occurrence of gangrene by maintaining the vital warmth of the part and assisting the circulation. After actual gangrene has set in, prevent the occurrence of sepsis; support the powers of the system, and endeavour to allay nervous irritability.

In cases of impending gangrene it is not often that the surgeon can remove any local cause and so prevent its occurrence; but in some few cases it can be done. When, for instance, an impending gangrene is due to strangulation, the symptoms are at once relieved by the removal of the cause of the strangulation, as in the familiar example of a strangulated hernia. So again the relief of local tension may do much to avert impending gangrene in those cases where it is threatening from inflammatory causes. In cases of diffuse cellulitis, gangrene may be averted by timely incisions. With regard to gangrene arising from constitutional causes, much may be done to prevent the occurrence of gangrene. A good illustration of this is afforded in the diabetic form of the disease. If a patient who is the subject of diabetes will only rigidly conform to the dietetic rules which are imposed upon him, he will run little risk of getting diabetic gangrene. Or again, if an individual who is eating rye bread, as soon as he gets the premonitory diarrhœa, with cold extremities and cramp, will at once abandon the bread he is eating and obtain it from another source, he will in all probability arrest the impending attack.

Another indication in averting an impending attack of gangrene is, as far as possible, to *maintain the vital warmth* of the part. The limb or part affected should be wrapped in a thick layer of cotton wool, over which may be placed a flannel bandage, loosely applied, or the limb may be swathed in a small blanket. Hot-water bottles should be placed in the bed, but not actually in contact with the limb.

Means must be taken to assist the circulation, and by this is meant especially the return of the blood to the heart through the veins, where it is always liable to stagnate, even where the cause of the gangrene is some defect in the arterial circulation, from loss of the propelling power of the vis a tergo. This may be done to a certain extent by raising the limb on an inclined plane, which will facilitate the venous return by gravity. Care must be taken, however, if the gangrene is in the lower extremity, as it so often is, not to raise the limb too high, otherwise it will produce a bend in the common femoral artery, opposite the hip joint, which may interfere with the free flow of blood through the vessel. In another way the circulation through the veins may be assisted in cases of impending gangrene, and this is by gentle massage in the course of the venous circulation. If in a case, for example, of ligature of the femoral artery, the limb becomes cold, swollen, and dusky, and gangrene threatens, the systematic stroking of the limb with the flat hand in an upward direction at repeated short intervals will do much to empty the veins, assist the circulation, and avert the attack.

When gangrene has actually set in, one of the most important points in the treatment is to prevent the *occurrence of sepsis*. This is to be done by a complete and thorough disinfection of the whole limb affected, and by its subsequent protection from the admission of bacteria by an efficient antiseptic dressing. If the part becomes septic it at once leads to severe constitutional disturbance from the absorption of septic products; and, in addition to this, to violent inflammation at the line of demarcation, with profuse suppuration and all the evils which may arise therefrom.

During the process of ulceration and suppuration the system must be supported, and this must be done principally by hygienic and dietetic means, assisted by tonics and stimulants. No definite rules can be laid down, but each individual case must be treated according to its necessities. Care must be taken to preserve strict cleanliness and free ventilation; the food must be light, nutritious, and capable of easy digestion. Stimulants are usually required, but must be given with discrimination and care, so as not to upset the digestive organs. The indiscriminate use of them is to be strongly deprecated. With regard to tonics, quinine, strychnia, and the vegetable bitters, especially cinchona and gentian, are to be most relied upon.

Finally, the nervous irritability from which a patient with gangrene in most cases suffers, is to be allayed by opium. Perhaps in no cases is opium of more use than in cases of gangrene; it relieves the pain, soothes the patient, and though possibly it does not act as a specific, as was formerly supposed, it appears in some way or other to assist in arresting the progress of the disease. It may be given in full doses, and it is astonishing how well patients seem to take this drug, and how little it interferes with or upsets the digestive organs.

3. **Specific forms of gangrene.**—Cases of gangrene due to sepsis are now fortunately very uncommon, and therefore it will not be necessary to devote much time to them. Of these perhaps the *spreading traumatic gangrene* is the one most likely to occur, and at the same time is one of the most terrible on account of the rapidly fatal nature of the disease if energetic means are not at once taken, and even when they are the case generally ends in death.

Spreading traumatic gangrene.—This disease is a form of gangrene which attacks wounds, and is due to the introduction of a septic micro-organism. The form of organism most commonly met with is the bacillus septicus, or bacillus of malignant œdema of Koch. It is a rod-shaped body, rather longer and more slender than the bacillus anthracis. In its behaviour it somewhat resembles the tetanus bacillus. It is anaërobic, and wounds which are attacked are generally those which have been soiled by earth, so that it seems probable that, as with the tetanus bacillus, the favourite habitat of the infecting microbe is earth. Another point of resemblance is that the micro-organism multiplies in the tissues in and about the wound, and does not find its way into the general circulation, and that the general symptoms of septic poisoning are due to the poisons which they generate and not to the micro-organisms themselves.

Symptoms.—The disease sets in about the second or third day after the injury. The edges of the wound become swollen and everted, and vesications form on them. There is a slight fœtid discharge of brownish serum, but no pus. Severe pain is complained of, and the patient looks wan and anxious, and has a quick, irregular pulse. In a few hours there is swelling for some distance around the wound of a dark, purplish red colour, mottled with brown and green. This swelling rapidly increases, and extends principally and primarily along the course of the lymphatic vessels. Soon emphysematous crackling of a very marked kind is detected, owing to the rapid evolution of large quantities of gas. Once started, the disease spreads with enormous rapidity, and no tendency to arrest ever shows itself, but it spreads to the trunk and the patient dies within a very short time of the advent of the gangrene. The constitutional symptoms early assume the character of acute septic poisoning, and the patient rapidly lapses into a comatose condition and dies.

Treatment.—The only treatment for this formidable condition is immediate amputation as high as possible above the gangrenous part. If the disease is recognised early and the treatment adopted promptly, a certain percentage of cases may be saved. By amputation all further absorption of septic material is prevented, and the surgeon has only to combat with the amount already absorbed. What that amount is no one can say ; if the dose has been large, the patient will assuredly die ; if, on the other hand, the dose is smaller, the patient will recover if only he can be kept alive long enough to eliminate the poison from his system. Everything must therefore be done to support and husband the patient's strength, by the free administration of wine, brandy, and diffusible stimulants, with such fluid nourishment as the patient can take.

Hospital gangrene is a spreading infective inflammation, which attacks wounds, and is attended with rapid formation of sloughs. It is intensely contagious, and when once it breaks out in a ward it is liable to spread from patient to patient. It has been thought to be infectious, and that the microbes might be carried by the air, but it seems probable in these cases that flies may be the carriers of the contagion. This disease is happily now almost unknown, but formerly it was exceedingly common in times of war, from the accumulation of the wounded, with foul, suppurating sores, in military hospitals, and from want of proper attention to cleanliness and sanitary arrangements.

When hospital gangrene attacks a wound the surrounding integument becomes inflamed, swollen and œdematous, and of a livid red colour. The wound becomes covered with a greyish coloured slough, which spreads rapidly, and all the tissues become converted into a thick pulpy greenish mass, which is exceedingly fœtid. Pain of a severe, burning character is complained of. The gangrenous condition extends very rapidly, and all the tissues of the limb may become involved ; muscles are destroyed, vessels are eaten into, and profuse hæmorrhage may occur, joints may become opened, and even the bones do not escape, the periosteum becoming destroyed and the bones necrosed. Accompanying this local condition there is great prostration ; a feeble, quick, intermittent pulse ; sweating ; profuse diarrhœa ; nausea and vomiting. These symptoms are followed by delirium, coma, and death.

Treatment.—Should hospital gangrene occur, the patient must at once be isolated, and the hospital in which it broke out closed and thoroughly disinfected. With regard to the patient himself every possible precaution must be taken to prevent contagion ; everything which touches the gangrenous parts should be immediately burned, and the most rigid antiseptic precautions taken. The gangrenous tissue should all be scraped away, and the whole surface of the wound well swabbed out with fuming nitric acid or seared with the actual cautery. The part is then to be dressed with an antiseptic dressing, and the patient's strength supported by plenty of fluid nourishment.

Phagedæna.—There is another form of disease which is closely allied to hospital gangrene and by some is regarded as the same thing. It is, however, a disease of a far milder type than the former, and is not characterised by the same amount of prostration, nor is it so frequently fatal. It seems, therefore, better to mention it under a separate heading, though fortunately it is, like hospital gangrene, practically banished from surgery. Formerly it was very common, and during the time I was House Surgeon to St. George's Hospital, I had an opportunity of watching nearly a hundred cases.

The disease presents itself in two forms: in one, the gangrenous form, the wound becomes dry, and the surrounding parts swollen, tense, and of a bright red colour. Then the wound becomes covered with a black slough, which rapidly extends, and large pultaceous sloughs are formed, implicating muscles, vessels, and bones &c. (fig. 33). In the other form, the ulcerative, a pulpy membrane appears on the wound, under which there is a rapid liquefaction or ulceration of the tissues. To this the name of *wound diphtheria* is sometimes given. The disease is accompanied by considerable depression. Unlike hospital gangrene, in the majority of cases, the process is arrested after a time, a line of demarcation is formed, and the wound eventually cicatrises.

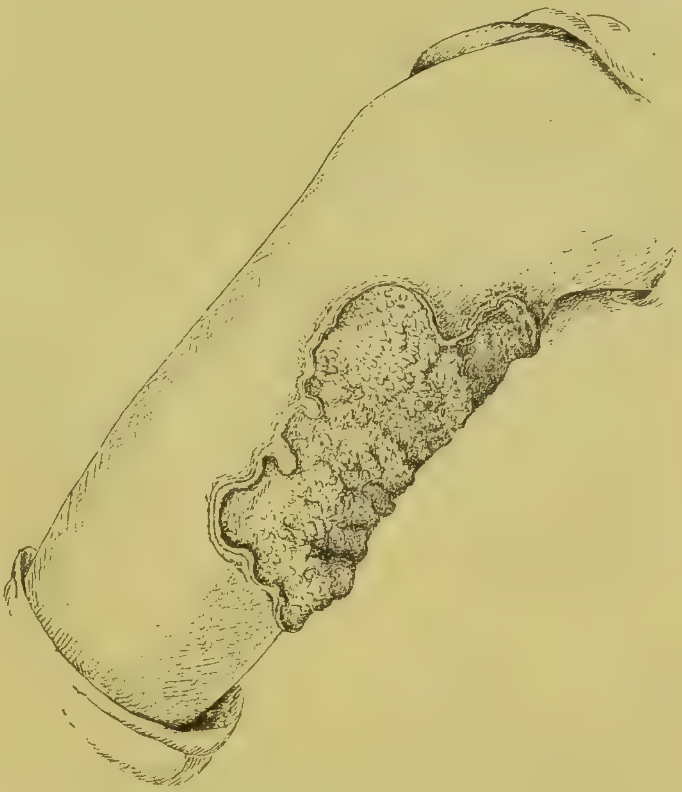

FIG. 33.—Phagedæna of the calf of the leg. (From a drawing in the Museum of St. George's Hospital.)

Treatment.—In the treatment of this affection the destruction of the gangrenous tissues by fuming nitric acid or the actual cautery is generally advocated. The constant irrigation of the wound with sulphurous acid, and the free administration of opium internally, was the plan of treatment which seemed to be attended with the best results in the cases which came under my own observation.

Cancrum oris.—Cancrum oris is a form of gangrene which attacks the mouth, and is due to the infection of a bacillus, which has been isolated and cultivated, and which can be found in the tissues at the edges of the slough. The disease occurs in weakly children, generally between the ages of two and five, and is especially liable to attack those who are convalescing from one of the exanthematous fevers, measles or scarlet fever. It commences as a gangrenous ulceration of the inner surface of the cheek, which becomes greatly swollen; the skin tense and shining and of a dusky red hue: in the centre of this swelling a black spot appears, which rapidly spreads, and the whole cheek falls into a condition of gangrene. If a view of the inside of the mouth can be obtained, it will be found that on the inner side of the cheek there is a deep excavated ulcer, covered with a greyish, pultaceous slough. The gums are spongy and ulcerated. The breath is fœtid, and there is constant dribbling of saliva. The general condition is serious; the temperature is high: the pulse very rapid and weak; there is great prostration, and the child speedily becomes unconscious and dies comatose, in the majority of cases in four or five days.

The only **treatment** which appears to be of any avail is the cutting away of all the sloughs which have formed, and then thoroughly applying nitric acid to the whole of the exposed surface. Nothing short of this appears to be of the slightest use, and this proceeding in a child of two or three years old is a serious one. After the operation the part should be constantly irrigated with Condy's fluid (℥i to Oj) or some other antiseptic, and as much fluid nourishment given as can be taken. Stimulants, especially port wine, are also required. Under this treatment a certain percentage of cases recover.

Noma pudendi.—A similar disease to cancrum oris occasionally attacks the vulva of female children, and is believed to be due to the infection of the same micro-organism. It generally attacks the labium, which becomes swollen, red and tense; on its internal surface may be seen an excavated ulcer covered with a greyish slough. The whole labium becomes gangrenous, and the disease rapidly extends and may destroy the recto-vaginal and vesico-vaginal septa; so that, as I have seen, the three cavities of the bladder, vagina, and rectum may be thrown into one foul gangrenous chasm, from which the urine and fæces are expelled. The treatment is the same as for cancrum oris: scrape away the sloughs and apply strong nitric acid; apply antiseptics, iodoform being probably the best; and support the strength of the patient.

Boils.—A *boil* or a *furunculus* is a form of gangrene. It may be defined as an acute circumscribed inflammation of the dermis around a hair-bulb and its glandular appendages, going on to death of the tissue.

Boils—and carbuncles as well—are due to the introduction of an infective organism, and it is generally believed that this microbe is one of the pyogenic organisms, the staphylococcus pyogenes. At all events this micrococcus is constantly to be found in the discharge from a boil in its early stages, and Garré proved by an experiment on himself that it was capable of causing boils, for he rubbed a culture into his arm and so produced a crop of boils. There is one peculiarity, however, which is very striking, if this is really the infective organism of boils: and that is, being a pus-producing organism, it is in these cases invariably followed by gangrene.

The organism enters through the hair follicles; and parts exposed to friction, as the nape of the neck from the collar, the shoulder from the braces, or the buttock in rowing men, are peculiarly liable to this disease from the micro-organisms being rubbed into the follicles.

The **predisposing causes of boils** are numerous. They may occur in the plethoric, when it is believed by some that they are due to the habit of eating too much animal food; or, on the other hand, they may occur in the debilitated, as after one of the exanthematous fevers, or in cases of diabetes or Bright's disease. They are not uncommon in the young, but may occur at any period of life. Sudden changes in the habits of life, as in the athlete when he goes into training, or in a sudden change from a sedentary occupation to more active pursuits, will often produce a crop of boils; for it is a common thing to find when one boil appears, that it is followed by others, and the patient may suffer from this condition for weeks or months, one boil appearing after another in fairly rapid succession.

Symptoms.—A boil begins as a small pimple, which causes considerable irritation and itching. This is followed by inflammation of the skin around, and a conical, hard, circumscribed tumour is formed, from the centre of which a hair can generally be seen protruding. The swelling is of a dusky red hue, and considerable pain of a tensive throbbing character is complained of. Soon a little pustule forms on the summit of the boil; this bursts and leaves an opening, at the bottom of which may be seen a greyish white slough. Suppuration takes place, the slough gradually separates, leaving a little granulating cavity, which gradually fills up. Occasionally the nearest lymphatic glands become enlarged and tender, but rarely suppurate.

Treatment.—In many cases an abortive treatment may be pursued with advantage in quite the early stage of the disease. If the hair which can be seen protruding from the centre of the boil is seized with a pair of forceps and plucked out, and the part then protected from the air and friction, no gangrene may take place and the effused inflammatory material may become reabsorbed. The plan which I have usually adopted is to cover the part with a thick coating of gutta-percha dissolved in chloroform, and this has seemed to answer very well. Should, however, the pain continue, it will be evident that suppuration is taking place, and the gutta-percha shield should then be removed. Nothing will be found to relieve the pain so much as an incision, followed by an antiseptic fomentation. This is generally all the local treatment that is necessary. At the same time an endeavour must be made to find the cause of the outbreak, and the patient treated accordingly. Failing this, careful dietetic measures and hygienic surroundings, with change of air and tonics, are indicated.

Carbuncle.—It is somewhat difficult to draw a sharp line of distinction between a boil and a carbuncle, and perhaps the best definition of the latter is that it is a collection of boils. Hence follows the main distinction between the two. The boil is a *circumscribed* inflammation; the carbuncle is a *spreading* inflammation, because fresh little patches of inflammation (i.e. boils) are constantly forming at its margins. As we have already seen, both diseases are believed to be due to the same micro-organism, but a carbuncle is altogether more extensive; it involves the subcutaneous tissues, and a large slough or a number of smaller ones, each with its separate orifice, is formed.

As regards the predisposing causes, there are some points of difference between the boil and the carbuncle. The latter is rarely met with in the young; in fact the disease is usually one which occurs in advanced middle life. It is much more common in the male than in the female. The two most common conditions which predispose to it are diabetes and a lowered condition of the system. In my experience the most common class of people liable to be attacked by carbuncle are men servants out of place—persons who have been in the habit of living freely and are suddenly reduced to bad and insufficient food.

Symptoms.—The disease begins as a flat inflammatory swelling, which rapidly increases, so as to form a more or less circular elevation with defined edges and of a purplish red, dusky hue. This is accompanied by very severe pain of a bursting, throbbing character. There is fever of a low type, with marked depression. Soon a number of pustules form on its surface, which burst and leave apertures, through which a greyish white slough may be seen. While this is going on the carbuncle may be spreading at its margin and may eventually attain an enormous size, sometimes a foot or more in diameter. The small apertures coalesce, and the slough is gradually thrown off, leaving a granulating wound, which slowly cicatrises. In many cases the patient dies of septic absorption or exhaustion before this has taken place.

Treatment.—The treatment of carbuncle, especially as regards the propriety of incising it, is one about which there is a great difference of opinion; some surgeons advocating incisions in every case, others as uniformly rejecting them. There can be no question that very many cases of carbuncle do very well without incision; but, on the whole, seeing that an incision is the best means of relieving the tensive pain which is complained of, there are not many cases, I think, where an incision to relieve tension is not beneficial; though I am far from advocating the free crucial incision which was considered necessary in former days, and which was often attended by a considerable loss of blood which the patient could ill afford to bear. In my own practice I have obtained the best results by making a small incision in the centre of the swelling, and then introducing a Volckman's spoon, and scraping away as much of the slough as can be got away with it. This proceeding is not attended by much hæmorrhage, and it unquestionably relieves the patient of his pain, and hastens his recovery. Some surgeons, however, deprecate this plan of treatment on account of the risk which they say there is of opening up veins and so causing pyæmia; but with careful antiseptic precautions, and by powdering the surface afterwards with iodoform, this risk is very slight, and need not, I think, outweigh the great advantages to be obtained by following this course. After the incision is made, the part should be covered with a hot boracic pad covered by oil silk or jaconet. The patient's strength must be supported by fluid nourishment, and such amount of stimulant as is considered necessary from the condition of the pulse &c. If there is much pain, opium should be given, and in many cases quinine will be found to be of service. I have found great benefit from combining carbolic acid with the quinine in these cases. Mr. Rushton Parker advocates the operative extirpation of carbuncle, as saving both pain and time, and as a protection to life in severe cases, by excision of all the diseased tissues with the knife or scissors.

BEDSORES

In speaking of the different varieties of gangrene, allusion has been made on one or two occasions to bedsores; it will be therefore desirable, before we leave this subject, to say a word or two more on this condition.

As we have already seen, these bedsores may be of two different kinds: (1) the ordinary bedsore, which is simply produced by pressure;

(2) the acute bedsore, which occurs from pressure applied to a part where there is deficient innervation.

The *ordinary bedsore* usually occurs in weak and debilitated people who are confined to bed, and who on account of their weakness are unable to constantly change their position, so that pressure is always being made on the same part. It occurs, therefore, chiefly over the sacrum, the most common situation; the heels and the spines of the scapulæ; or if the patient is lying on his side, over the trochanter. They may, however, also occur from the pressure of splints or other rigid appliances. The skin first of all becomes dusky red, and then black, and a slough forms. In some cases the slough may extend deeply, exposing the bone, or even, at the back of the sacrum, opening the spinal canal. The condition is attended by profuse discharge, which further weakens an already debilitated subject, and may be the cause of death. The preventive treatment resolves itself into good nursing, and in the hands of a good nurse bedsores of this kind ought to be of very rare occurrence; by frequent slight changes in the patient's position, by relieving the pressure by a water pillow, or thick felt plaister cut into a ring; by strict cleanliness, and drying the skin whenever it has become wetted from any cause, and by applying some lotion which will harden the skin, of which, perhaps, corrosive sublimate dissolved in spirits of wine is the best, bedsores ought very rarely to take place. If a bedsore threatens, change of position is imperative, and the application of a little boracic acid ointment will then be all that is necessary; but if a slough has formed, a hot boracic pad under oil silk is the best application.

Acute bedsores.—Acute bedsores occur in those cases where a part has been deprived of its nerve influence. They are principally met with in surgical practice after fracture-dislocation of the spine, and are very frequently the cause of death in these cases. The gangrene takes place on any part which has been exposed to pressure, and has been deprived of its nerve influence, and also sometimes on places where there has apparently been no pressure, but where there is not a very free circulation of the blood, as over the malleoli. The tendency to the formation of bedsores in these cases is no doubt increased by the irritation produced by the presence of fæces or urine in the bed, which the patient often passes unconsciously, so that good nursing is of essential importance. These are cases of moist gangrene in which the disease comes on very suddenly and spreads rapidly, and soon exhausts the patient's strength. The case must be treated on ordinary principles.

CHAPTER II

ERYSIPELAS

Erysipelas is an infective inflammatory process which may affect the skin, mucous or serous surfaces, with or without implication of the underlying cellular tissue; or which may affect the cellular tissue alone without any implication of the cutaneous, mucous, or serous surfaces.

In this chapter it will be considered mainly as affecting the cutaneous surfaces and the cellular tissue, and will be described under three heads: 1. **Simple cutaneous erysipelas**, where the inflammation is confined to the skin. 2. **Cellulo-cutaneous** or **phlegmonous erysipelas**, where the skin and cellular tissue beneath are involved. 3. **Cellular erysipelas** or **cellulitis**, where the inflammation affects the cellular tissue with little or no implication of the skin. In all forms the inflammation is characterised by the same tendency to spread with great rapidity by continuity of tissue.

Pathology.—The exciting cause in all cases of erysipelas is the introduction of a micro-organism, but it is not yet certain whether the micro-organism is the same in the two varieties of erysipelas—namely, that which attacks the cutaneous surfaces, and that which attacks the subcutaneous tissue. With regard to their morphology and their behaviour in artificial cultivations, the infecting microbes cannot in most cases be distinguished from each other; but when introduced into the human body, the effects they produce are in one respect characteristically different from each other. In the simple cutaneous erysipelas the inflammation spreads without, as a rule, any tendency to suppurate, whereas in the cellulo-cutaneous erysipelas suppuration is the rule, rather than the exception.

About the simple cutaneous erysipelas there is no doubt. It has been abundantly proved by the experiments of Fehleisen and others that there is a specific microbe, the *Streptococcus erysipelatis*, which is the essential cause of cutaneous erysipelas. Fehleisen cultivated this micro-organism on gelatine and coagulated serum through many generations, until he believed that he had got a perfectly pure cultivation; this he inoculated not only into the lower animals, but also into the human subject, and produced typical erysipelas. These results have been confirmed by others, so that there is no question as to the specific nature of this microbe. Furthermore, Fehleisen denied, as the conclusion at which he had arrived as the result of his experiments, that this micrococcus can cause suppuration. If this is true, we must account for those rare cases where suppuration does undoubtedly occur in cutaneous erysipelas by supposing that there has been a mixed infection of the streptococcus erysipelatis with some of the pyogenic organisms.

The cellulo-cutaneous erysipelas is also caused by a streptococcus, but it is extremely doubtful whether this is the S. erysipelatis, and it is believed by most that the organism which produces this form of the disease is the streptococcus pyogenes. Some, however, believe that the cellulo-cutaneous erysipelas may be produced by a mixed infection of the two organisms. On the whole, considering the difference in the behaviour of the two organisms, it seems probable that they are distinct from each other, in spite of their morphological similarity. If they are the same, the difference in their behaviour is most probably due to the difference of the tissue in which they are implanted. It can scarcely depend, as Baumgarten suggests, on the varying virulence of the organism or the idiosyncrasy of the patient.

The streptococcus in the cutaneous form of the disease is only to be found at the spreading margin of the erysipelas. When the inflammation has existed some short time it is impossible to demonstrate them, as they are obscured by the fibrinous exudation which has taken place.

Predisposing causes.—The local predisposing cause of erysipelas is a wound or abrasion through which the micro-organism can effect an entrance. Although the wound is not always demonstrable there must have been some abrasion of the surface, and in the early stage of the disease it can generally be found; later on it becomes obscured by the inflammation and may be undiscoverable. Any wound of any size in any stage of its progress may be the starting point of erysipelas; a slight scratch, a leech bite, an acne pustule, scarification of parts affected with œdema, may all be the means by which the microbe effects an entrance. But the disease would appear to occur more frequently after contused and lacerated wounds than incised ones; probably on account of the greater difficulty that there is in disinfecting them. Again, the presence of decomposing discharges in a wound renders it more liable to be attacked by erysipelas.

The **general predisposing causes** of erysipelas may be considered under two heads, either as affecting the patient or his surroundings. The great predisposing cause of erysipelas as regards the patient himself is a vitiated condition of the blood. This may be, and often is, due to habitual intemperance; the man who is in the habit of taking an excessive amount of alcoholic stimulants is particularly liable to be attacked with erysipelas. But the vitiated condition may be set up by other causes; amongst the poor, privation of the necessaries of life and want of sufficient and proper food may be the disposing cause; so again, morbid states of the blood induced by disease of the eliminatory organs, e.g. albuminuria, diabetes, and disease of the liver, are frequent predisposing causes of erysipelas. Mental emotions, and especially prolonged anxiety, by depressing the nervous system, is also a cause of erysipelas. It is sometimes said that certain individuals are naturally predisposed to the disease, and Verneuil records a case of a woman who had seventy-nine attacks of erysipelas of the face. Probably, however, these recurring cases are to be explained by the fact that the patient suffers from one of the predisposing causes above mentioned, which induces the attack.

As regards the patient's surroundings, it is a well-proved fact that erysipelas may become epidemic, as the result of some conditions of the atmosphere; it is said to be more common in the spring and autumn and during the prevalence of east winds, but all that is known for certain is that the disease is more prevalent at some seasons than at others. More potent causes are bad ventilation and faulty hygienic conditions, and especially a vitiated atmosphere from the presence of decomposing vegetable or animal matters.

I. **Simple cutaneous erysipelas.**—In simple cutaneous erysipelas the inflammation is confined to the skin and starts from a wound or abrasion, which is most frequently situated on the head or face, this portion of the body having apparently a special predilection for this disease. It not uncommonly takes its origin in the little cracks or fissures which so frequently occur at the muco-cutaneous orifices: thus the angle of the mouth; the ala of the nose; the inner canthus of the eye; the external auditory meatus, are all not uncommon sites for the commencement of erysipelas. It also occasionally commences in a scalp wound, or after the removal of a sebaceous tumour, if proper antiseptic precautions are not taken.

The incubation period is unknown and would appear to vary very considerably. Even in experiments on the lower animals this is found to be so. Fehleisen in his experiments found that it varied from fifteen to sixty-one hours. In the human subject it is said to vary from a few hours to eight days.

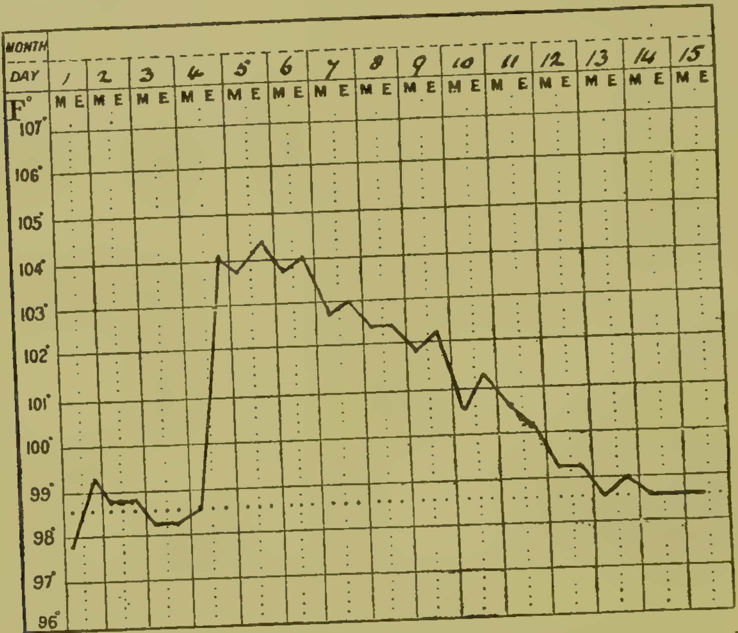

FIG. 34.—Chart of a case of erysipelas following a scalp wound, showing a gradual defervescence.

Symptoms.—The characteristic sign of the disease is a red rash which, starting from the wound, spreads rapidly. The colour of the rash varies somewhat; at first it is a rosy red, and afterwards generally bright crimson, but sometimes a deep livid red. Occasionally there is a yellowish or orange tinge. In the earlier stages the redness disappears readily on pressure; later on, especially if it is of a dusky hue, it does not disappear so readily and leaves a yellow tinge behind. The redness is accompanied by swelling and a certain amount of œdema, so that it pits slightly on pressure. The margin of the swelling and redness is sharply defined and presents an abrupt, irregular outline, which is slightly raised above the level of the surrounding healthy skin, and can be plainly appreciated by the finger passed over it. The œdema in the simple cutaneous erysipelas is not great, except in those cases where there is a quantity of loose cellular tissue beneath, as in the eyelids, scrotum, or labia; here the œdema is very considerable. The skin of the inflamed part is tense and shining, and covered over with minute vesicles, or sometimes bullæ. These at first contain clear serum, which after a time becomes turbid. Stiffness is complained of at first, succeeded by a burning sensation and a feeling of tension. The pain is always increased on pressure, and is sometimes so great that even the application of a dressing to the part is painful to the patient. The redness spreads widely, and as it spreads is always characterised by the same abrupt, irregular margin. Here the redness is brightest, for the colour has a tendency to fade in the centre as it spreads at the circumference. The wound, if it is of any size, from which the erysipelas started, becomes dry and glazed, and ceases, if in the suppurating stage, to secrete pus, but discharges merely a little thin sanious fluid. The surface of the wound presents no granulations, but often becomes covered with a layer of greenish grey lymph. The duration of the attack is very variable; it generally lasts from two to ten days, but it may continue twice as long and still terminate in recovery. The defervescence of the fever which accompanies the disease is in some cases abrupt; the temperature falls suddenly almost to normal, and coincidently with this the redness begins to disappear and desquamation to take place. In other cases the decline of the temperature is much more gradual (fig. 34). The vesicles and bullæ dry up and form crusts. Sometimes after the redness has disappeared a peculiar bronzing of the skin is left, which may persist for some time.

The **constitutional symptoms** of erysipelas are decided and well marked. The patient, who may have previously been in good health, feels ill, there is a sensation of chilliness, alternating with heat, sometimes even a distinct rigor; there is headache and nausea and frequently vomiting. In young children the attack is often ushered in by convulsions, which take the place of the rigor. There is a sudden rise of temperature, which may indicate a difference of 4° or 5° between the morning and evening registration. The pulse is accelerated, and the tongue furred and creamy. Very often there is pain and enlargement of the nearest group of lymphatic glands, and the two signs of a sudden rise of temperature and an enlargement of the glands in the neighbourhood of a wound are often strong indications of an approaching attack of erysipelas. The fever, after the appearance of the eruption, rapidly assumes an asthenic type. The temperature continues high, 102° to 104° F., with slight remissions in the morning and exacerbations in the evening. The pulse is quick and weak. The tongue becomes brown and dry, and sordes collects on the teeth. The bowels are usually constipated and the motions dark and offensive. As the disease subsides an attack of diarrhœa frequently sets in, or diarrhœa may be present from the first. The urine is scanty, loaded with lithates, and in the later stages of the disease frequently albuminous. In severe cases, especially when the erysipelas attacks the head, there is delirium, which is usually of a low muttering type, but in some cases the patient may become violent and maniacal.

Simple cutaneous erysipelas is not often fatal, unless it is complicated by severe visceral disease, especially albuminuria, or when it attacks the head and face and spreads to the membranes of the brain or, through the mouth, to the pharynx and larynx. In the aged and young children it is more commonly fatal. In infants there is a form of erysipelas, which attacks the skin of the abdomen during the separation of the stump of the umbilical cord, which is known as *Erysipelas neonatorum*, and which is especially fatal.

Erysipelas of mucous surfaces.—When erysipelas attacks mucous surfaces the appearances and the constitutional symptoms are practically the same as when it occurs on the cutaneous surfaces, with the exception that usually there is more swelling and œdema, and the inflammation is more prone to run on to ulceration. The mouth, nose, the vulva and vagina and the rectum are the places where it generally occurs. The disease is ushered in by the same sudden rise of temperature. The mucous membrane becomes swollen and intensely injected, and bullæ, which often ulcerate, form on its surface. When it attacks the nose or mouth it is liable to extend to the pharynx and larynx, and produce œdema of the glottis, which gives rise to exceedingly grave and urgent symptoms.

The **diagnosis** of erysipelas is not generally difficult after the eruption has become fully developed. Erythema, herpes, acute eczema, lymphangitis are all diseases with which it is said it may be confounded: with regard to the first three the slight amount of the constitutional disturbance and the character of the eruption are sufficient to distinguish them. Perhaps herpes is the disease most likely to be mistaken for erysipelas, because here the constitutional disturbance may be severe; but the redness usually follows the course of the cutaneous nerves, and never crosses the middle line of the body. In lymphangitis the redness is in the form of minute streaks running in the course of the lymphatic vessels; and as the two diseases are frequently conjoined, the differential diagnosis is not of paramount importance.

Erysipelas has occasionally a tendency to assume an erratic form; that is to say, it subsides in one part of the body and breaks out in another, and at each new outbreak there is an exacerbation of the constitutional symptoms. This form was known by the older writers as *metastatic erysipelas*. It appears to occur most frequently as a complication in pyæmic cases, and therefore its occurrence must always be looked upon as of the gravest importance.

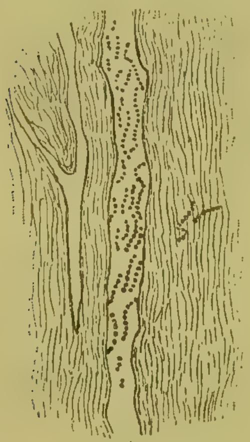
FIG. 35.—Streptococci in the lymph spaces in a case of erysipelas. (After Cornil and Babes.)

Pathology.—After death the red colour disappears, but the swelling and œdema remain. Upon microscopic examination it is found that the diseased tissues are infiltrated with a serous exudation, in which are numberless migratory cells. The endothelium of the lymph spaces is swollen, and the lymphatics and lymph spaces contain micrococci. From this and from the manner in which the redness spreads in irregular patches it seems probable that the micrococci travel by the lymph paths (fig. 35). Fehleisen states that no organisms are to be found in the blood-vessels. Micrococci are also to be found in the dermis, at the spreading margin only and not throughout the rest of the inflamed surface. From this it follows that the disease is due to the invasion of micrococci, which infiltrate the lymph channels and not the blood-vessels: that their products excite inflammation, with attendant migration of leucocytes, which destroy the micro-organisms; and that the fever is due to the absorption into the blood stream of the chemical products of the bacteria and not to the bacteria themselves.

The post-mortem appearances of those who have died from erysipelas are those of death from blood poisoning. The blood is thin and fluid; the lining membrane of the blood-vessels and heart is blood-stained. The kidneys and liver are congested and their epithelium cloudy. The spleen is often enlarged and sometimes soft and diffluent. The lungs are usually congested, and Busk has stated that the smaller pulmonary vessels often contain blocks of altered white corpuscles. Bastian has described a similar condition in the vessels of the brain.

Treatment.—The *preventive* treatment of erysipelas simply resolves itself into strict attention to hygienic measures and the isolation of cases affected with the disease. In former years erysipelas was an extremely common disease, and used sometimes to spread up and down a ward for an indefinite period. At other times it would appear to locate itself in some part of the ward, and attack patient after patient who was placed in the beds in this particular corner of the room. In these cases it was probably due to some local cause, as a faulty sewer or the emanations from a dustbin. Nowadays, however, the practice of aseptic surgery has practically prevented erysipelas from occurring in our wards, though cases are still admitted from without.

With regard to the treatment of the disease there is no question that the strictest attention should be paid to perfect ventilation with pure air. The old-fashioned plan of smothering a patient up in a close room, with curtains around his bed and every means taken to prevent any current of air through the room, was exceedingly prejudicial. The first and strictest attention should be paid to proper ventilation; the patient should be placed in a large and airy room; all curtains and hangings should be removed, and the nurse should be instructed to thoroughly ventilate the room, care, of course, being taken not to expose the patient to any draught. The treatment of erysipelas should always be commenced with a purge; a little blue pill followed by a saline draught is perhaps the best form to administer. The issue of a case of erysipelas depends in a great measure upon the patient being able to take the requisite amount of nourishment; and as there is generally a good deal of derangement of the gastro-intestinal mucous membrane, a brisk purge is the best means of getting his digestive organs into as good a condition as possible to enable him to take the requisite nourishment. Erysipelas is accompanied by a fever of an asthenic type, and therefore salines and tonics are the remedies which are indicated. The plan I usually adopt, especially if there is thirst and dryness of tongue, is to give the compound tincture of bark, in an ammoniated effervescing saline, with excess of ammonia. The administration of the tincture of the perchloride of iron in large and repeated doses has been much vaunted as a specific for erysipelas, especially by Bell. I have tried it frequently, and have never been able to satisfy myself of its efficacy, and its tendency to produce constipation is a decided objection to its use.

The diet should be fluid, consisting of strong beef tea, broth, milk, given in such quantities as the patient can digest. Stimulants are also generally required in these cases in varying quantities according to the exigencies of the case. When the patient has been habituated to the consumption of large quantities of alcohol, they are occasionally required in very considerable doses. But I think harm is sometimes done by giving too much stimulant; a very small amount frequently repeated will generally do more good than a large quantity given at one time. The pulse should be the indication as to the amount to be given, and it should be especially observed about the sixth or seventh day, because any sign of flagging and increased frequency in the beat at that time is always a circumstance of grave importance and generally indicates that more stimulation is required.

As to the *local* treatment of erysipelas, I need say very little. The enormous number of applications which have been vaunted at different times as specifics for this disease prove that there is nothing which can be regarded in this light. I believe that the indications for treatment are to apply some mild non-poisonous antiseptic, and to as much as possible exclude the air. I therefore usually recommend that the affected part should be covered with boracic acid ointment spread on linen or butter cloth and covered with a thick layer of medicated cotton wool. This is a light application, which is not painful to the patient and seems to answer very well. Some surgeons prefer lotions, boracic acid lotion, solution of perchloride of iron, solution of nitrate of silver, &c. These should never be applied cold, and when applied hot require frequent renewal, and this disturbs the patient and causes him pain.

II. **Cellulo-cutaneous** or **phlegmonous erysipelas.**—This form of erysipelas, as we have already seen, differs from cutaneous erysipelas in its causation, being due in all probability to the infection of a different organism, the streptococcus pyogenes; it also differs in the important fact that it always runs on to suppuration and perhaps sloughing, and therefore, though it presents a close clinical relationship to the cutaneous form, it is better to regard it as a distinct disease. The inflammation in these cases is of a much more intense character than in the cutaneous form, and is accompanied by a greater degree of constitutional disturbance. It affects the subcutaneous cellular tissue as well as the skin, generally being limited by the deep fascia of the part.

Causes.—This form of erysipelas usually occurs in the broken down in health, in the habitually intemperate, in those who have suffered from privation and insufficient food, or in patients afflicted with chronic disease of the kidney. It occurs generally in cases of wounds which have penetrated the subcutaneous tissue, and therefore is not uncommon in scalp wounds, where the aponeurosis of the occipito-frontalis has been injured and the loose areolar tissue under it exposed, and in cases of compound fracture. It may, however, also occur from a small wound or abrasion, as the chafing from an ill-fitting boot, which has been neglected and has been allowed to become septic.

Symptoms.—At first the disease is characterised by a rapidly spreading swelling and redness. The swelling is due to œdema, and is soft and pitting. The redness is of a uniform scarlet hue, and though fairly defined does not present the same abrupt margin as in the cutaneous form of the disease. After a short time the redness becomes darker and of a more dusky hue, and the swelling instead of being soft becomes hard and brawny and no longer pits on pressure. This is due to the effusion of inflammatory products into the cellular tissue. The surface of the inflamed tissues becomes covered with blebs containing sero-purulent fluid, which is sometimes blood-stained. There is severe pain of a burning character. During this time the inflammation is gradually spreading, until in the course of two or three days the whole of a limb, most frequently the lower extremity, is involved It is swollen to perhaps twice its natural size, the skin is tense and shining, becoming mottled with purple patches. About the fourth or fifth day from the commencement of the attack, or it may be sooner, a further change takes place in the swelling; it is no longer hard and brawny, but becomes soft and boggy, and pitting again takes place on pressure. This is due to suppuration and sloughing having taken place in the subcutaneous tissues. If an incision is made into the affected part, the tissues will be found to be gelatinous in appearance, and to be infiltrated with an opaque, sero-purulent fluid, which shortly becomes pus. The skin becomes purple and finally black and gangrenous, and gives way. Large masses of foul gangrenous tissue in a state of putrefaction protrude from the openings and are thrown off. And thus in extreme cases the greater part of a limb may be denuded and the deep fascia exposed, beneath which as a rule the inflammation does not extend; but the disease may destroy the periosteum covering subcutaneous bones, as the tibia, and cause necrosis, or it may extend into joints, causing suppuration in them and destroying them. The great characteristic in the process is that the suppuration, after it has taken place, does not tend to point and burst like an ordinary abscess, but extends laterally, and it is not till the skin has died, from its blood supply having been cut off, and separated, that a discharge of the pus and sloughs takes place.

If the patient survive, a large denuded surface is left, which takes long to cicatrise, and leaves a dense cicatrix, which contracts and produces deformity and permanent disablement of the limb.

The **constitutional symptoms** of this condition are very severe. The fever at first may be of the sthenic type, with a full, bounding pulse, a hot, burning skin, and a high temperature, 103° to 105° F. Rigors are also of common occurrence and are often repeated. When, however, suppuration and sloughing set in, the fever, often suddenly, undergoes a change, and this change is due to septic absorption. The pulse continues quick, but it becomes weak, irregular and intermittent; there is great restlessness, inability to sleep, and delirium, usually of a low muttering kind; nausea and vomiting, and very often diarrhœa with offensive motions. The patient lapses into a semi-conscious condition and death supervenes. Or some complication may occur, such as pneumonia or pleurisy, which may carry him off.

Treatment.—The general treatment of cellulo-cutaneous erysipelas must be carried out on the same lines as the cutaneous form, except that support and stimulants require to be more freely given. Bark and ammonia as medicine, and as much fluid nourishment as the patient can take and digest, with stimulants, such as brandy, port wine, egg and brandy mixture, are the principal indications for treatment; and sometimes, especially in those cases where the patient has been in the habit of taking large quantities of alcohol, the stimulants have to be given with a free hand, and the issue of the case will depend in a great measure upon whether he is able to take large quantities of stimulants without upsetting his digestive organs. The local treatment consists in a great measure in making incisions to relieve tension. As soon as the skin becomes hard, brawny, and indurated, incisions should be made some two or three inches in length over all parts of the inflamed tissue, so as thoroughly to relieve the tension of the skin; if this is not done the skin will slough, and great destruction of tissue will be the result. If the bleeding is excessive the wounds should be plugged for a few hours with iodoform gauze, and then enveloped in boracic lint wrung out in hot boracic lotion and covered with jaconet or some other waterproof material. If the bleeding is not great, the dressing may be applied without previous plugging. The limb should be raised, so as to facilitate the return of the venous blood. In cases where the disease is in quite the early stage, before brawny induration has set in, it may be safe to postpone the making of the incisions for a few hours and to apply the boracic fomentation, or paint the inflamed area with equal parts of extract of belladonna and glycerine, and then apply a hot fomentation. If at the end of this time the swelling is diminished and the skin begins to present a wrinkled appearance, the disease may terminate in resolution and no incisions may be required.

III. **Cellulitis** or **cellular erysipelas** resembles the two conditions which we have been considering in the fact that it is an acute infective inflammation, but it differs from them inasmuch as it is not a definite disease due to a specific cause, but that it arises from different kinds of infection. There is no doubt that, like the cellulo-cutaneous erysipelas, it is in many cases due to the infection of the streptococcus pyogenes, but it may also arise from bites of snakes or dissecting wounds, and also from some animal poisons, especially the extravasation into the cellular tissue of fœtid urine in cases of ruptured urethra. No doubt, in these cases the streptococcus may be present, but other organisms are also to be found, and are equally potent in the production of the disease.

The disease, as its name implies, affects only the cellular tissue, occurring in those situations where there is no skin, as in the pelvic cellular tissue, or in the subcutaneous tissue, the skin not being involved, or only secondarily involved, by the inflammation.

The disease is not uncommon in the pelvic cellular tissue, after operations on or wounds of the pelvic organs, and in women after parturition; it also occurs in the cellular tissue of the neck from acute necrosis of the jaw or ulceration of the pharynx or larynx, when it has received a distinctive name, *Ludwig's angina*; in the cellular tissue beneath the occipito-frontalis after scalp wounds; and, in fact, in any situation where there is cellular tissue. The severest form is probably that which is due to the septic poison from a post-mortem wound; and these cases present this peculiarity, that the inflammation may attack tissues remote from the wound, and between which and the wound no direct continuity can be traced, as in cases of diffuse cellulitis of the axilla from a dissection wound of one of the fingers.

Symptoms.—The symptoms consist in swelling of the part affected: the swelling soon becomes hard and brawny, and there is some mottled discolouration of the skin over the swelling, if it is the subcutaneous cellular tissue which is affected. There is pain of a burning character which is greatly increased on pressure, so that the patient cannot bear any handling or examination of the part. Later on, if the case is untreated, the skin may become involved and gangrenous, from its blood supply being interfered with by the infiltration of the tissues underneath. But the affection of the skin is quite secondary to that of the tissues beneath. Where the cellulitis occurs in tissues remote from the surface, as in pelvic cellulitis, the diagnosis is not so clear. There is deep-seated pain, increased on pressure, and great constitutional disturbance, with a high temperature and probably rigors. There may be a little œdema and redness of the skin in the neighbourhood, but this is by no means constant. Deep-seated tension or resistance may be felt on manual examination.

The constitutional symptoms are of a very severe type. There is great prostration of the nervous system and speedy collapse, especially when the disease is due to a poisoned wound from post-mortem examinations. There is a high temperature; profuse sweating; a quick, feeble, intermittent pulse; a brown and dry tongue; vomiting and diarrhœa and low muttering delirium. In many cases there is absorption of septic matters, and death results from sapræmia or septicæmia.

Treatment.—In the treatment of cellulitis, decisive measures are of paramount importance, and the only way of saving the skin, in the subcutaneous forms of the disease, and preventing sloughing, is by timely and free incisions. These should be made early and carried down into the inflamed tissues so as to afford a ready exit for the effused products of inflammation. Where the cellulitis occurs in deeper parts, and more remote from the surface, incisions are also imperatively called for, and should be boldly undertaken as soon as the disease is recognised, otherwise the patient will probably succumb in a few days if the disease is very acute, or in the more chronic forms, after some time, from exhaustion or pyæmia. After the incisions, warmth and moisture, preferably in the shape of boracic acid fomentations, must be applied to facilitate the separation of the sloughs.

As regards the general treatment the same lines must be adopted as in cellulo-cutaneous erysipelas. Wine and brandy, combined with bark and ammonia and good nourishing fluid food, must be given.

Paronychia or **Whitlow.**—It is convenient in this place to describe *Paronychia* or *Whitlow*, an infective inflammation of the finger, which is closely allied to erysipelas. It is the result of inoculation with septic organisms which find an entrance through some slight scratch or abrasion. It is often accompanied by very great pain, by constitutional disturbance which is out of all proportion to the amount of local mischief, and is frequently followed by very serious consequences. It is usually the custom to classify the varieties of the disease under four heads according to the nature of the tissue implicated, and this is a convenient arrangement, as the symptoms and consequences of these varieties are different in importance and degree.

I. **Paronychia ungualis.**—This is a form of the disease which is of comparatively little importance. It arises from the introduction of some septic matter through a slight prick or scratch, or, what is more common, through an abrasion at the margin of the nail, which is popularly known as 'hang-nail.' It is often seen on the fingers of surgeons, dressers, nurses, and such-like, who are constantly exposed to the risk of inoculating themselves with some septic material. The disease is confined to the ungual phalanx; the pulp of which becomes swollen and slightly red, the redness being greater on that side of the nail where the inoculation took place. There is very considerable pain of a throbbing character, and the whole end of the finger feels hot. Very rapidly a drop of pus forms under the epidermis, at the point of injury, and this may burrow under the nail, producing increased pain. The **treatment** consists in evacuating the drop of pus. This may be done by shaving away the cuticle until the little bead of pus is reached, and its discharge will give immediate relief. If the suppuration has extended under the nail, this must be cut away with a pair of sharp-pointed scissors, following the course which the pus has taken. The finger should then be enveloped in a hot boracic dressing, and will soon get well.

II. **Paronychia cellulosa.**—This is a much more painful condition than the last, and affects the fat and areolar tissue of the terminal phalanx. This also, in all probability, in every case arises from the introduction of septic matter through a small wound, though in many cases the wound cannot be detected. The end of the finger becomes swollen and red, and there is intense throbbing pain in the part, which often prevents the patient from sleeping. The disease is usually confined to the terminal phalanx, but lymphangitis and enlargement of the nearest set of lymphatic glands may be a consequence of the condition. The constitutional disturbance in these cases is often very great. The temperature is high, and partly from the pain, and partly from the want of sleep, the patient very rapidly gets into a depressed condition, with a feeble and rapid pulse, and sometimes even delirium. The ravages of the disease, though localised to the particular part, are very often extensive; thus, especially in those in whom the cuticle is very thick, the pus burrows through the whole of the areolar tissue of the pulp, which eventually sloughs; or the inflammation may extend to the periosteum of the ungual phalanx, which becomes destroyed and the bone perishes; or the inflammation may extend to the tendon of the deep flexor, and this may slough.

Treatment.—The only treatment for this condition is an early and free incision, and the sooner it is made the better; if before the occurrence of suppuration, it will be to the patient's advantage, as the disease is often cut short and no suppuration occurs if a timely incision is made. In addition to this the patient is saved much pain and suffering by this proceeding. The incision should be made deeply in the middle line of the pulp of the finger through the whole of the inflamed tissues. The patient should then soak his finger in a hot boracic bath for some time, and hot boracic dressings should subsequently be applied. The hot boracic bath may advantageously be repeated once or twice a day, and the arm should be carried in a sling with the hand at a higher level than the elbow.

The other two forms of whitlow are usually the direct consequences of paronychia cellulosa; but as they are believed to occur occasionally independently of this condition, it is necessary to allude to them under distinct headings.

III. **Paronychia tendinosa.**—In these cases the sheath of the flexor tendons is involved, and it is therefore sometimes known under the name of *thecal abscess*. It may arise from a puncture of the sheath and the direct introduction of some septic matter into it, but it is most frequently the consequence of the extension of a septic inflammation from the pulp of the finger into the sheath. The importance of this form of whitlow arises from the fact that the septic organisms, having effected an entrance into the sheath of the tendons, may spread up it and produce extensive ravages. A moment's consideration of the anatomy of these structures will at once show that whitlow of the thumb and little finger, involving the sheaths of the flexor tendons, is a more formidable affection than the same disease in the other three fingers. The sheath of the flexor longus pollicis and of the flexor tendons of the little finger are continuous with the two great synovial sheaths which pass under the annular ligament (fig. 36), and therefore inflammation affecting the sheaths of the tendons of these two digits may spread widely up the forearm, whereas with the other three digits the inflammation is usually confined to the hand.

The **symptoms** usually commence in these cases much in the same way as in paronychia cellulosa, with throbbing pain, swelling, and redness of the terminal phalanx, but the inflammation soon extends and the whole finger becomes involved. Then the palm becomes implicated; it becomes red and swollen, doughy and distended with pus, and if the thumb or little finger is the one involved, the inflammation may creep upwards under the annular ligament into the forearm, and this may sometimes become involved almost to the elbow. The inflammation is not, however, confined to the palm of the hand, for even in those fingers where the sheaths of the tendons terminate at about the level of the metacarpo-phalangeal joints, an extension may take place by the pus bursting through the cæcal ends of the sheath and, infiltrating the tissues of the hand, extend beneath the annular ligament into the forearm. The back of the hand becomes red, swollen, and puffy, and if radical treatment is not adopted the whole of the lower part of the extremity becomes involved in a suppurative inflammation; matter burrows in every direction, points and bursts; joints become involved, and suppurative arthritis is set up and the articulations destroyed; tendons slough and are thrown off, and the limb becomes a useless member, for which amputation is the only resource. The pain and constitutional disturbance which attend this condition are very severe, and if early treatment is neglected the patient develops a low, irritative form of fever, which is a further inducement to the surgeon to recommend amputation as the only means of saving the patient's life.

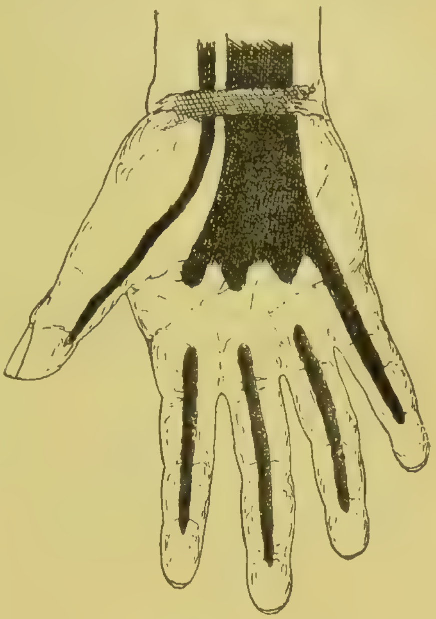

FIG. 36.—Diagram showing the arrangement of the sheaths of the tendons of the flexor muscles of the fingers and thumb.

Treatment.—All this serious condition of things can be averted in most cases by an early and free incision. If as soon as the disease is recognised no temporising is allowed, but a free incision into the sheath of the tendon is made, and a ready exit for the evacuation of the products of the inflammation is afforded, these untoward results in the vast majority of cases will not occur. A little care must be exercised in making these incisions. In the finger the incisions should be made in the middle line, opposite the middle of each phalanx and not over the inter-phalangeal joints, for fear of accidentally opening them. In the palm they should be made over the metacarpal bones in their distal half, so as to avoid wounding the palmar arch, or the digital vessels and nerves which lie in the interdigital spaces. In the later stages of the disease, if the case has not been seen till then, incisions must be made wherever there is an inflamed boggy swelling; the only chance of obtaining a useful arm is by free incision, thorough drainage, and careful antiseptic treatment. In the after treatment of these cases, the application of warmth and moisture in the form of hot boracic dressing, with the immersion of the arm for an hour or two once or twice a day in a hot boracic bath, will be found the most beneficial. The patient will require a liberal nutritious diet, and probably the administration of some stimulant will be indicated.

IV. **Paronychia ossea** is that form of whitlow where the periosteum of the last phalanx becomes involved in the infective inflammation, and as a result is destroyed and the phalanx necroses. As an initial affection it is probably very rare, and those cases of paronychia ossea which we meet with are generally the result of an extension of the disease affecting the pulp of the finger to the periosteum. In these cases the symptoms resemble very much those of the ordinary form of onychia, except that perhaps the pain is more severe and is especially bad at night, and the amount of constitutional disturbance is great. If the incision for the relief of this condition has been delayed until the periosteum has been entirely separated from the bone, the latter inevitably perishes and the wound made does not heal until the bone separates at the joint and either comes away or is removed. The wound now closes, leaving a distorted and deformed shrivelled extremity to the finger.

The **treatment** of this condition is exactly the same as in the others, and consists in making an early and free incision.

CHAPTER III

SEPTICÆMIA AND PYÆMIA

The terms **Septicæmia** and **Pyæmia** have been somewhat vaguely applied and in different manners by different authors. In order to clear the ground it is necessary to define the sense in which they will be used in this work.

By the word **septicæmia** we mean the fever produced by the presence of bacteria or their toxic products in the blood.

By the word **pyæmia** we understand something more than this; that is to say, pyæmia is septicæmia *plus* the formation of secondary abscesses in various tissues and organs of the body; so that in these latter cases there is a fever due to the presence of bacteria or their products in the blood, and there are in addition purulent collections in various parts of the body, which in themselves may generate toxic products, and so not only keep up but increase the fever which already exists.

But we must go farther than this. Experimental research has gone far to prove that under the head of septicæmia we must include two different conditions. If, for instance, putrid meat solutions are injected into a given number of animals in sufficient quantities, they all die with well-defined symptoms. But suppose a single drop of this same solution is injected into the same number of animals, say a dozen: in a certain number, perhaps two or three, definite symptoms will be set up which will terminate in death, whilst in the rest no ill effects will be produced by the experiment. We have therefore two distinct conditions. In the first a poison is injected into the blood stream, and if it is introduced in sufficient quantities it invariably causes death, and in these cases the symptoms supervene directly after the introduction of the poison; if it is injected in smaller quantities it produces the same train of symptoms, but they are not so severe and the animal does not die, but after a longer or shorter interval perfectly recovers; and again, if injected in a very small quantity no appreciable effect is produced. In this respect the poison resembles in its effects the symptoms produced by the introduction into the system of an ordinary vegetable poison, as, for example, opium or one of its derivatives. Supposing, for instance, we inject under the skin of an animal a large dose of solution of morphia, the animal becomes comatose and dies, and this the more rapidly the larger the dose; but suppose a smaller dose is injected, the animal presents all the symptoms of opium poisoning, but after a time recovers and is apparently none the worse for the experiment; and thirdly, if a very minute quantity is injected, no appreciable result is observed.

The form of septicæmia, then, in which the poison, the product of putrefaction, produces results proportional to the amount of poison introduced, and in which the symptoms come on immediately after the introduction of the poison, is named **sapræmia** or **septic intoxication.**

The other class of cases, where the effects produced are not proportional to the dose, where only some of the animals inoculated show any signs of disease, and where the signs, when they do occur, do not develop until some time after the inoculation, we term **septicæmia** or **septic infection.**

It will be necessary, therefore, to consider the three conditions—sapræmia, septicæmia, and pyæmia.

SAPRÆMIA

Sapræmia or **Septic intoxication.**—This condition has already been alluded to in the chapter on Inflammation, but it is necessary to describe it a little more in detail in this place. It must not be confounded with the primary fever following injuries, which, as we then saw, is probably due to the presence of fibrin ferment in the blood, whereas this condition of septic intoxication is due to the introduction into the blood of one or more chemical products generated by the decomposition or putrefaction of dead animal matter in a wound. These chemical products are called *ptomaines*, and are of a very complex nature. Many attempts have been made to isolate them, and with a certain amount of success. Bergmann was the first to obtain one of them, which he named *sepsin*, from decomposing beer yeast; this was subsequently obtained by Panum from putrid meat infusion. Subsequently, numerous workers have obtained other poisonous alkaloidal substances from putrid albuminous principles, which it is scarcely necessary to enumerate, as sepsin may be taken as a type.

Sepsin was first obtained by Panum by digesting putrid fibrin in water, and filtering. Boiling alcohol was added to the solution thus obtained, and a precipitate was thrown down. This was washed, dried, and redissolved in distilled water, and a perfectly clear solution, free from morphological elements, was the result. This solution was found to possess most poisonous properties, and when injected into the blood stream of animals produced symptoms identical with those which are produced in cases of sapræmia arising from a putrefying wound. Moreover, these symptoms came on immediately after the introduction of the solution into the blood, and varied in intensity according to the amount of poison introduced. If the dose was small certain definite symptoms resulted, varying in intensity with the amount of the dose, but after a time passed off, and the animal recovered. If, on the other hand, the dose was large, severe symptoms at once supervened: vomiting and diarrhœa, with the passage after a time of bloody stools; muscular twitchings, followed by loss of muscular power; very rapid, laboured breathing, and speedy death from failure of the heart's action.

The post-mortem appearances were those of death from blood poisoning. The blood was fluid or imperfectly coagulated; the lining membrane of the heart and vessels blood-stained; minute petechiæ were to be seen on the serous surfaces; the lungs were congested; and the spleen enlarged, soft, and diffluent. It is quite clear that these symptoms could not have been due to the introduction of micro-organisms, for the solution which produced them was a perfectly clear fluid free from any organised body. And further than this, the symptoms set in immediately after the introduction of the poison, and therefore there was not time for the organisms, if there had been any, to incubate ; and finally the severity of the symptoms was directly proportional to the amount of the dose, which is not the case in infective conditions. Finally, it should be stated that in these experiments no micro-organisms could be found in the blood, and if the blood of an animal killed in this way was injected into the blood stream of another animal, no effect was produced. It is quite clear, therefore, that this is not an infective process, but that sapræmia is due to the introduction of a chemical poison ; just in the same way as the hypodermic injection of strychnia or any other toxic agent, if injected in sufficient quantities, produces poisoning. But at the same time it must be borne in mind that bacteria are concerned in the process, for though, as we have endeavoured to show, they are not concerned in producing the symptoms, they are necessary for the production of the poison which does so, for without their aid putrefaction cannot be set up.

Symptoms.—The two most prominent sets of symptoms of sapræmia are those produced by disturbance of the nervous system and derangement of the gastro-intestinal mucous membrane. Soon after decomposition sets in and its products are absorbed by the blood, the patient begins to feel ill, and complains of headache and loss of appetite ; there are alternating heats and chills, and possibly there may be a rigor. The temperature will be found to be above normal, registering 102° or 103° F. Then disturbance of the digestive organs sets in ; there is nausea, and the patient may reject his food ; this is followed by diarrhœa, at first feculent, and then consisting of mucus and sometimes blood. The vomiting now becomes constant and the patient refuses food, complaining that everything he takes makes him feel sick. The tongue is covered at first with a white creamy fur, but after a time tends to become brown and dry. The skin is clammy, and often there is profuse sweating. The urine is deficient in quantity and loaded with lithates.

If the patient lives he becomes anæmic. In fatal cases delirium sets in and passes on to coma. In very acute cases, where the amount of poison absorbed is large, the symptoms much resemble those which are produced by the experiment on the lower animals, alluded to above. There is great collapse from the first ; twitching of the muscles, followed by great muscular exhaustion ; restlessness, constant diarrhœa soon becoming bloody, dyspnœa, delirium, loss of consciousness, and death.

The symptoms in cases of sapræmia vary within certain limits, according to the difference in the kind of putrefaction set up, since the nature of the ptomaines formed varies in different varieties of decomposition.

The great and characteristic difference between the symptoms of sapræmia and septicæmia is the difference in their behaviour under treatment. In sapræmia, if the putrefactive focus is removed, the symptoms begin to subside at once ; but this is not so with septicæmia.

Pathology.—The post-mortem appearances present nothing characteristic ; they are, in fact, merely those which we expect to meet with in cases of blood poisoning, and are identical with what has already been described as the post-mortem appearances of animals killed by the injection into their blood of sepsin ; the same fluid or semi-coagulated blood, the same blood-stained endocardium and intima of the blood-vessels, and the same congested condition of the lungs and gastro-intestinal mucous membrane, with enlarged and diffluent spleen.

Treatment.—The treatment of sapræmia is generally easy, and in some cases eminently satisfactory. It consists merely in thoroughly clearing away all putrid matter, and cleansing the part with a strong antiseptic solution (corrosive sublimate 1 in 1,000, or carbolic acid 1 in 20). This, with free drainage, is all that is required in a simple uncomplicated case; the symptoms will rapidly subside and the patient recover. But it must be borne in mind that this condition is not unfrequently complicated with some infective mischief, and that symptoms of pyæmia may show themselves in a few days. Too confident a prognosis should not, therefore, be given in the first instance.

Sapræmia is often followed by considerable debility, partly the result of nerve exhaustion and partly the result of the anæmia which is set up, and therefore tonics, especially a combination of iron and quinine, with change of air and good nourishing food, are indicated after the patient's recovery from the more immediate symptoms of the disease.

SEPTICÆMIA

Septicæmia is due to the introduction of an infective virus, probably pyogenic micro-organisms, into the blood. These organisms are in the majority of cases introduced through a wound, and their source has been some putrid substance, such as the corpse of a person recently dead of some septic disease. It seems probable that they may find an entrance either directly by the blood-vessels or indirectly through the lymph stream. In addition to this there are certain grounds for believing that these micro-organisms may occasionally effect an entrance into the blood by absorption through the alimentary canal or respiratory tract, though the cases in which this occurs are rare.

The reasons for believing that septicæmia is due to an infective micro-organism circulating in the blood, and not, like sapræmia, due to the absorption of the chemical products of these organisms, are very conclusive. If we compare the two diseases we shall find the greatest differences, and there are certain facts in septicæmia which can only be explained by assuming that some living organism by some means or other effects an entrance into the blood and there grows and multiplies. In the first place the minutest quantity of the poison, on the point of a lancet or a needle, introduced under the skin is sufficient to produce the death of an animal, and if the animal is examined after death the blood will be found swarming with micro-organisms, which must have been derived from the few introduced on the point of the instrument. Therefore, unlike sapræmia, the effect produced is not proportional to the dose. Secondly, in septicæmia, the effect of the poison does not show itself immediately after its introduction. If a small amount of some putrid material from the body of a person who has died from some septic disease is introduced under the skin of an animal, there is at first no result; the animal runs about and feeds as if it were perfectly well, and it is only after the lapse of a certain, though variable, period of time that symptoms of poisoning begin to show themselves. There is, in fact, a latent period, or, more properly speaking, a period in which there are no external manifestations, and during which the organisms are multiplying in the system. This is called the *incubation* stage, and its duration varies. Probably one of the causes of this varying period of incubation is due to the way in which the microbes effect an entrance into the blood, whether directly through the blood or indirectly through the lymph stream. Thirdly, the poison is distinctly infective. We have seen that in animals who have died of septicæmia, the blood is teeming with micro-organisms ; now if a drop of this blood is inoculated into another animal it may produce the same train of symptoms ; whereas the blood of an animal dead of sapræmia is quite innocuous, and when injected into a second produces no effect.

It must be mentioned that these facts have been elicited principally by experiments on the lower animals; for in the human subject sapræmia and septicæmia are frequently present together in the same subject. As the source of the virus is some decomposing material, and this decomposing material is very frequently a putrid wound, the chemical products of putrefaction producing sapræmia are often absorbed into the blood at the same time as the micro-organisms producing septicæmia are circulating and multiplying in the same fluid.

As regards the duration of the incubation period in man, nothing definite can be stated. As we have just said, septicæmia is generally complicated with sapræmia, and an absolutely uncomplicated case of the former disease rarely occurs, so that there are not sufficient data on which to form an accurate opinion. It is generally believed that about six or eight hours represent the average duration of the incubation period.

We now pass on to discuss another most important point in connection with this subject, which has been abundantly proved by experiments on the lower animals ; and that is, that inoculations do not always succeed. If, for instance, a minute quantity of some putrid material, not sufficient to produce any noticeable symptoms of sapræmia, is inoculated into a given number of animals, in the majority no ill effects will be produced, whilst the minority will die in a few hours with symptoms of septicæmia. Koch, for instance, injected one drop of some putrid meat infusion under the skin of the back of some mice. In about two-thirds of them no apparently ill effects followed ; whilst in the remaining third, about twenty-four hours after the inoculation, certain symptoms were set up which terminated in death in a few hours. It is clear, therefore, that something more is necessary than the introduction of the virus into the blood, and this is, favourable conditions under which it can grow ; that is to say, a condition in the recipient of the poison favourable to its development.

We have seen that in sapræmia, when the putrid material—the manufactory of the poison, if we may so term it—is removed, marked improvement follows, and, in an uncomplicated case, recovery is the result. This is not so in septicæmia. The tendency here is towards an increase of the symptoms and the death of the patient, and no amelioration in the symptoms is produced by removing the part which has been inoculated, so that it is clear that the manufacture of the virus does not take place at the seat of inoculation.

Symptoms.—Clinically we divide septicæmia into two main classes, *acute* and *chronic*, and in describing the symptoms it is necessary to distinguish the one from the other.

Acute Septicæmia.—In the acute form of septicæmia the general symptoms are usually preceded by some local changes at the seat of inoculation, owing to the fact that the case is not one of pure septicæmia, but is mixed up with a certain amount of sapræmic complication.

The wound becomes inflamed, there is very considerable, sometimes intense, pain in the part, and generally a little suppuration. In other cases there may be inflammation of the lymphatics spreading up the limb, or a diffuse cellulitis starting from the wound. The patient begins to feel ill and depressed ; he complains of intense headache and nausea, and this is speedily followed by vomiting. Frequently a sharp rigor occurs, and the thermometer registers a temperature of 103° F. or 104° F., falling perhaps a degree or so in the morning, to rise again in the evening. Towards the end of the second day delirium supervenes, followed after a time by convulsive twitchings, and after this, stupor, coma and death ; this last takes place about the fourth or fifth day, though it may be delayed to the sixth or seventh. Early in the case the heart begins to fail, and the pulse becomes weak, quick, and irregular. The respiratory movements are also quickened and very shallow. The urine is always scanty, and towards the end of the case becomes albuminous, but, unlike sapræmia, there is not always diarrhœa, though it is present in some cases, but is rarely attended with discharge of blood.

Chronic Septicæmia.—The symptoms of chronic septicæmia differ from the acute rather in degree than in kind, but run a much longer course, often lasting three or four weeks. There are the same symptoms of nervous depression, and the gradually increasing weakness. The temperature is not usually so high, and has a tendency to have a greater remission in the morning than in the acute form, though it never reaches normal. Occasionally, in these cases a rash appears over the body, generally resembling scarlet fever, but sometimes of a papular or urticariform character. Pulmonary complications are also not infrequent—pneumonia or bronchitis—and these very often hasten the fatal termination. Pleurisy and pericarditis are other complications which sometimes arise.

Pathology.—In the post-mortem examination of cases of septicæmia, as in sapræmia and other forms of blood poisoning, petechial extravasations are found on the serous surfaces, and are no doubt the cause of the pleurisy or pericarditis. The post-mortem appearances are much the same as in cases of sapræmia. The blood is uncoagulated, and, as we have seen, swarming with bacteria. The lining membrane of the heart is blood-stained, and in some cases ulcerative endocarditis is found to exist. The brain and cord, and especially the medulla, are congested, and occasionally minute points of extravasation are found in their substance. The spleen, especially in the chronic form, is much enlarged, so much so sometimes that the increase in size may be detected during the life of the patient. Its structure is soft and reduced almost to a creamy pulp. The liver is also enlarged and soft, its substance having undergone degenerative changes. The lungs are congested.

Treatment.—After septicæmia is once established, the treatment has been up to the present time most unsatisfactory ; but modern plans of treatment have been introduced, which hold out better hopes for the future. The first thing to do after the disease is established is to prevent any further absorption by at once either removing the parts at the seat of inoculation, or freely incising them and washing out the wound with a strong solution of carbolic acid or corrosive sublimate. This, of course, can have no effect on the general infection which has taken place ; but inasmuch as it is not always possible to distinguish this condition from sapræmia, these measures should always be adopted.

There seems to be very good reason to hope that in some of these cases, at all events, the injection of antistreptococcic serum may be followed by favourable results. Indeed, cases have been recorded where the best results have followed this plan of treatment. The subject is still, however, quite in its infancy, and is too undeveloped for us to be able to give any authoritative opinion. The injection can only be of use in streptococcic infections, and ought never to be employed until it has been proved either by microscopic or bacteriological examination that streptococci are present in the blood or discharge. Mr. Watson Cheyne believes that the main use of the serum will be as a prophylactic in those cases where infection by the streptococcus is likely to occur, and says that the evidence that the recovery is due to the injection is not to his mind quite satisfactory.

Another plan of treating these cases which has been advocated is by the intravenous injection of large quantities of normal saline solution (℥j to Oj). It is believed that the diarrhœa and diuresis which are induced will assist in eliminating the micro-organisms and their products. This plan of treatment, however, would appear to be more suited to cases of sapræmia, and does not appear to hold out the same prospects of success as the treatment by the antistreptococcic serum.

In addition to these plans of treatment, the administration of quinine in large doses and free stimulation, with such nutritious, easily digested food as the patient can take, is indicated. Other remedies which have been recommended are salicylate of soda, antipyrin and phenacetin, and the employment of the cold pack or bath to reduce the temperature. These remedies are probably not of much value. One of the best means of combating the depression which exists is the free inhalation of oxygen, but this has no curative effect on the disease.

PYÆMIA

We have already defined **Pyæmia** as being septicæmia plus the formation of secondary abscesses in various tissues and organs of the body. It is, in fact, a general infection of the blood with pyogenic organisms, leading to the formation of multiple abscesses.

Pathology.—The special point to consider in the pathology of pyæmia is why these secondary abscesses should form. We have first of all a general condition of septicæmia, that is to say, a general infection of the blood from the introduction of septic organisms, which have been absorbed from some putrefying wound and are multiplying in the fluid. But in addition to this we have the formation of multiple centres of suppuration in various parts of the body, which was not the case in true septicæmia, which we have just been considering. Why should these abscesses form? Experimental research has thrown some light on the subject. It has been proved by experiment that if a fluid holding in suspension solid particles too large to pass through the smaller arteries is introduced into the blood stream, these particles will be arrested in the small arteries and form an embolus, the effect of which will depend upon whether the particle is irritating or non-irritating in its nature. If small, *non-irritating*, solid particles are introduced into a systemic vein, they will flow along in the course of the circulation through the right side of the heart into the pulmonary artery, and become arrested in one of the small ramifications of this vessel. The circulation in the wedge-shaped piece of lung supplied by this small artery is thus interfered with, and it becomes filled with blood clot, possibly by giving way of the vessels and extravasation, but the exact way in which it occurs is not at present known. The wedge-shaped portion of lung becomes black in colour and quite solid. It forms what is called an *hæmorrhagic infarct*. This solid mass of lung tissue does not, however, suppurate or die, but gradually undergoes absorption and leaves a cicatrix behind. But if, on the other hand, the small solid particles injected into the blood are *irritating* or *infective*, that is to say, contain infective micro-organisms, then the effect is very different. We have the same formation of an hæmorrhagic infarct, but when formed it breaks down and softens, inflammation and suppuration occur in the tissues around, and an abscess is formed.

From these experiments a theory, which has been termed the mechanical theory, of pyæmia has been deduced. The wounds, associated with pyæmia are in an unhealthy condition, they are usually suppurating or sloughing, discharging a sanious or stinking pus, or covered with ashy lymph. The veins leading from these wounds are filled with thrombi, which are septic, that is to say, contain bacteria introduced into them from the wound. These septic thrombi, beginning at the veins in the wound, extend into the larger veins under the influence of the infecting organisms which they contain, become broken down, and small pieces of blood clot become detached and carried into the blood stream, along which they pass until, in the course of the circulation, they reach some vessel which is not sufficiently large to admit of their passage, and there they become arrested, and form an embolus, which results in infarction, and the piece of clot, being of an infective character, that is, carrying in it some of the bacteria from the wound, causes suppuration, and an abscess is formed.

This mechanical theory of pyæmia was until recently received as the true theory of the pathology of pyæmia and the cause of the formation of the secondary or metastatic abscesses; but there was always one difficulty to explain, and for this no satisfactory explanation could be given. It was this—that secondary abscesses might, and did frequently, occur in distant parts and in other organs beyond the first set of capillaries in the course of the circulation from the original centre of infection, and it was impossible to conceive how this could be the case if we accepted the mechanical theory of pyæmia in its entirety. O. Weber endeavoured to explain this by stating that very fine particles of thrombus might pass through the first set of capillaries, viz. generally those of the lungs, and give rise to embolism in the capillaries of the systemic circulation. It is believed now that in this embolic process the thrombus merely takes a passive part in the causation of the secondary abscesses, and that they are really caused by the bacteria which the clot contains, but that this merely acts as a carrier of the micro-organism. So that septic thrombi and emboli are not essential to the production of pyæmia, though they are important factors of it. There are therefore two processes in the formation of pyæmic abscess: first, the formation of an infective infarct; and, secondly, changes in the infarct produced by the organisms which are contained therein. These are similar to changes produced elsewhere; namely, septic inflammation and suppuration. And this septic inflammation and suppuration may occur without the formation of an infarct, as is proved by the fact that pyæmic abscesses can be produced experimentally by the intravenous injection of pure cultures of the pyogenic micro-organisms, though these pyæmic abscesses can be produced much more readily if in addition to the pyogenic organisms some non-irritating particles are injected at the same time. In this way, then, the fact can be explained that secondary pyæmic abscesses can be formed in any tissue or organ, and not necessarily in that organ where the first set of capillaries are met with in the course of the circulation from the infecting focus, for it is now known that these organisms, which can circulate everywhere without hindrance, are able to produce them. The micro-organisms may be derived either from the original focus of infection or from the secondary abscesses, and, circulating in the blood, become arrested in the capillaries of the systemic circulation. Around them coagulation takes place, forming a bacterial embolus, which excites inflammation and suppuration in the engorged tissues around, and thus the metastatic abscess is formed.

The micro-organisms which produce pyæmia are probably always the pyogenic micrococci ; of these the streptococcus pyogenes has been found in the greatest number of cases, though the staphylococcus pyogenes aureus is also frequently found ; more commonly there is a mixture of the S. pyogenes aureus and albus, and in some cases a mixed infection of streptococci and staphylococci has been found.

But the infection by micro-organisms is not the only thing necessary to produce pyæmia : there must be also a general predisposing condition which will favour their multiplication in the blood, for the presence of pyogenic organisms in a wound is not sufficient to cause pyæmia. This predisposition on the part of the recipient is usually anything which deteriorates the general state of health and prevents him from successfully combating the inroads of the organism. Such conditions as are produced by starvation, by chronic alcoholism, by faulty hygienic surroundings or by wasting diseases, such as diabetes or albuminuria, have long been recognised as predisposing causes of this disease.

Symptoms.—Clinically we recognise two forms of pyæmia, the *acute* and *chronic*, and the distinction between the two in typical cases is well marked, but between the two types there is a regular series of gradations, so that it is impossible to say where one begins or the other ends.

Acute pyæmia.—Let us take as an illustration the case of a wound of the scalp. The wound becomes septic, it is inflamed, foul and sloughy, and is discharging decomposing pus. The patient is apparently suffering from some febrile disturbance ; that is to say, the temperature, which rose after reaction had taken place, does not fall to normal, but continues above it, or if it has fallen to normal, again rises. At the same time the pulse is accelerated. A patient with these symptoms gets a severe rigor, and the temperature runs up to 105° or 106° F. This is followed by profuse sweating, and the temperature falls considerably, but not to normal. Such a condition of things is strongly indicative of pyæmia, but not characteristic. If, however, the rigor is repeated, the diagnosis becomes almost certain, for it is the recurring rigor which is pathognomonic of the disease. In septicæmia we may have a rigor, but it is not repeated. Coincident with the rigors we have rapid alternations in the temperature. A rapid rise up to 105° or 106° F., or it may be even higher, then a rigor followed by a profuse sweating, and a sudden fall of some five or six degrees, but never down to normal (fig. 37). During the rigors there is great acceleration of the pulse and respiration, and the patient's countenance betokens great distress. The rigors recur at irregular intervals, and this, together with the fact that the temperature between the rigors does not reach normal, serves to distinguish this disease from ague, in which there are also repeated rigors. In addition to these, the characteristic symptoms of pyæmia, there are also others. There is rapid emaciation, and the countenance looks worn and anxious, with sunken eyes and hollow cheeks. The skin presents a yellowish tinge, the so-called pyæmic jaundice, though the colour is not so marked as in true jaundice ; the pulse is very quick and weak, the tongue is dry and brown, and the teeth become covered with sordes. The secretions are arrested, there is usually constipation, but diarrhœa may occur towards the close of the case. The urine is high-coloured, scanty, and may be albuminous or contain blood. The breath and exhalations from the body have a peculiar sweetish odour, which has been compared to a faint odour of apples. The patient is despondent of himself, and frequently becomes delirious. In these cases, as in septicæmia, eruptions sometimes appear on the skin; of these a form of erratic erythema is perhaps the most common, but papules, sudamina, and urticaria are occasionally met with.

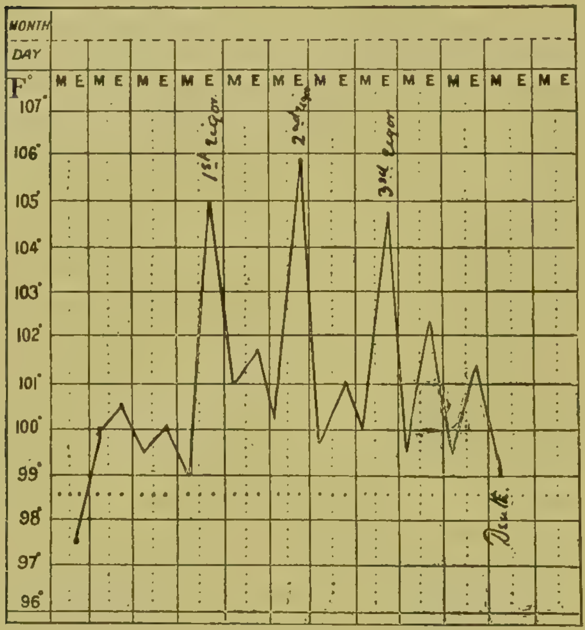

FIG. 37.—Chart of the temperature of a case of pyæmia.

The secondary abscesses may form in the viscera, in the joints, and in the subcutaneous cellular tissue, and give rise to special symptoms, though sometimes these symptoms are very slight, and abscesses may form without pain or other sign to draw one's attention to the part, and therefore are often overlooked until the post-mortem examination. Where abscesses form in the lungs there is perhaps a sharp sudden pain, which possibly may arise from the lodgment of the embolic block, followed by dyspnœa, and subsequently prune-juice coloured sputum. A careful examination may discover a dull spot on percussion. When the abscess is in the liver, there may be pain under the lower ribs on the right side, and jaundice ; in the spleen, enlargement of the organ ; in the kidneys, albumen and blood in the water and the micro-organisms of suppuration. When the joints are affected they become swollen, painful, and red, and when abscesses form in the subcutaneous tissue the skin becomes red and swollen, and the swelling fluctuates.

Chronic Pyæmia.—In chronic pyæmia the fever is less intense, and the disease may be protracted over weeks or months, and in some cases even years. It is frequently the result of some suppurative process about the genito-urinary organs, and occasionally occurs after parturition or abortion ; it is also not uncommon in cases of disease of bone attended with caries or necrosis. The secondary abscesses most usually attack the joints and subcutaneous tissues, more rarely the viscera. The rigors occur at long intervals, probably some weeks intervening between each rigor. A patient suffering from some local suppuration is suddenly attacked with a rigor, which is followed by a profuse sweat; during the rigor the temperature rises; and falls during the sweating, but does not quite reach normal. This attack leaves the patient exhausted and weak, and this weakness does not pass off. He expresses himself as not feeling quite well; he feels languid, disinclined to make any exertion, and is somewhat anxious and despondent about himself. The temperature is not steady; there is an evening rise to a degree or so above normal. This goes on for some days, it may be weeks, and then another rigor occurs. This further prostrates him, and the weakness increases. He begins now to emaciate. His appetite is capricious. And so the case goes on without any very definite symptoms, beyond the occasional rigor, followed by colliquative perspiration, until suddenly a joint becomes distended with fluid, or a fluctuating swelling, generally unattended with pain, appears in some part of the body. If this is opened, a quantity of oily, ill-formed pus escapes. In this condition the patient may linger for weeks or months, gradually becoming weaker and more emaciated, and may finally die of exhaustion, or, on the other hand, he may eventually recover with a shattered constitution, and it may be one or more ankylosed joints.

The **diagnosis** of pyæmia, and especially the chronic form, is by no means always easy. The chief points to rely upon in coming to a correct opinion are the repeated rigors at irregular intervals, and the condition of the temperature, which in the acute form is never normal, and in the chronic form is rarely ever normal for twenty-four consecutive hours, and in both forms is exacerbated from time to time when a rigor occurs, and falls again during the sweating stage.

The **prognosis** of pyæmia is always bad. Cases of the acute form of the disease almost always terminate fatally, and life is seldom prolonged beyond the twelfth or fourteenth day. In the chronic form of the disease, the outlook is a little more hopeful, but the majority of these also die. If they live, recovery is a very slow process, and generally leaves the patient in a shattered condition of health, and hopelessly crippled.

The **post-mortem appearances.**—The general post-mortem appearances are pretty much the same as those found in septicæmia. The blood is fluid, and shows little tendency to coagulate; microscopically, its red corpuscles are diminished, and its white increased. The lining membrane of the heart, especially that covering the valves, may be inflamed and ulcerated. The lungs, more particularly behind, are intensely congested and full of black blood. In them may be found secondary abscesses, which will present different appearances according to their age. In the most recent ones there is merely a wedge-shaped mass of solid tissue, sinking in water, of a dark red colour, very friable, so that it is easily torn; in a somewhat older one, the centre is broken down and contains a yellowish fluid, produced by gangrenous softening; this is surrounded by a zone of dark red solid tissue which is easily torn, and this again by a zone of intensely congested lung tissue; in still older ones, the solid portion is all broken down, and a true abscess is formed containing pus mixed with the débris of the lung tissue. The abdominal viscera, liver, spleen, and kidneys are congested, and may contain secondary abscesses.

When the joints are affected, the synovial membrane will be found swollen and inflamed, the cartilages more or less ulcerated, and the joint full of a thin, oily, ill-formed pus.

Treatment.—The treatment of pyæmia is mainly prophylactic. By careful asepticism and free drainage, pyæmia has been practically banished from British surgery. This, with pure air and avoidance of overcrowding, and care in preventing the contamination of one wound from another, ought to render pyæmia one of the most uncommon of diseases, and exclude it almost entirely from our hospital wards.

When pyæmia has set in little can be done in acute cases. The only plan of treatment is to support the patient's strength by a stimulating and tonic plan of treatment, and treat symptoms as they arise. Quinine in large doses is the remedy on which the greatest reliance is to be placed. This, with such fluid nourishment as the patient can take, a liberal allowance of wine or brandy, and strict attention to hygienic measures, sums up the treatment. In the more chronic form of the disease the same measures are to be adopted, with, in addition, incision of abscesses as soon as they form. In this class of cases the abscesses more frequently occur in accessible situations, and are therefore more under the control of the surgeon. Of course, in the acute form of the disease, if secondary abscesses occur in any situation where they can be reached, they should be opened, but this is rarely the case. They must in every instance be opened with antiseptic precautions. Sir James Paget points out that in the chronic cases the removal by operation of the seat of the original disease is frequently of the greatest benefit, and this should always, if possible, be done. By adopting this plan of treatment cases of chronic pyæmia occasionally recover, but in many of these cases the recovery is far from complete, and the patients often succumb some time afterwards from some such diseases as albuminuria or phthisis.

CHAPTER IV

SYPHILIS

It is customary to include under the term **Venereal disease** all those affections which originate primarily from sexual intercourse. Hence diseases entirely differing in their nature have been mixed up together and confounded with each other. Two of these diseases are merely local, have in most cases but a transient hold upon the system, and are followed by complete recovery as soon as the local trouble is got rid of; whilst the other constitutes one of the most obstinate affections to which the human subject is liable, reacts upon the whole constitution and attacks all the tissues of the body, and, moreover, may be transmitted from parent to offspring from one generation to another.

Under the head of Venereal disease are included (1) Syphilis, (2) Local contagion, (3) Gonorrhœa. The first two only will be considered in this chapter. Gonorrhœa will be described with the other diseases of the male urinary organs. John Hunter believed that there was only one virus or poison which produced all forms of venereal disease, and he classed them all together as syphilis; but Ricord and other observers conclusively proved by experiment that gonorrhœa had no connection with syphilis, and that the pus of a gonorrhœa could not produce a chancre if inoculated, and, on the other hand, the discharge of a chancre if introduced into the urethra never produced a gonorrhœa. It is quite clear that the virus of a gonorrhœa and the virus which produces a chancre are not the same. The two diseases, the local contagious sore and true syphilis, were, however, for some time classed together under the term syphilis, but more recently it has been shown that the poison of the two diseases is not identical, though they may co-exist together; that the one poison produces a sore which infects the system, while the other does not. Syphilis is therefore, in the restricted sense in which it is now used, a constitutional condition due to the introduction of a specific poison either by (1) inoculation, when it first of all produces a contagious sore or chancre, which is followed by constitutional symptoms; or (2) by inheritance, when the disease is transmitted from the parent to the child, and in which there are the constitutional symptoms without the local sore. We shall consider first of all syphilis produced by inoculation, and then that which is the result of inheritance; but before doing so it is necessary to discuss the relationship of the two sores, the infecting sore (Hunterian chancre) and the non-infecting sore (local contagious chancre), to each other, and to describe the latter.

The study of this subject has been rendered most difficult by the fact that the specific virus of true syphilis is seldom inoculated in a pure state. Venereal diseases owe their origin in the majority of cases to impure sexual intercourse, and the infecting virus of syphilis, which there is very good ground for believing is a small bacillus, is introduced into the recipient mixed up with the many varieties of micro-organism which frequent the male and female genital organs, or it may be with the specific virus of the soft sore, if there is one. Consequently it is extremely difficult to determine the relationship between the hard (infecting) and the soft (non-infecting) sore. These difficulties are further increased by the fact that the two conditions often occur in the same sore, and that the sore which in the first instance presents all the characters of a soft sore, after a time becomes indurated and is followed by the appearance of constitutional syphilis. The fact that we may get two varieties of sores, so different in their results, has led to different theories, which have been keenly debated. Some pathologists hold that the two conditions are produced by two wholly different poisons, and that the one disease can reproduce itself, and no other, though they admit that the two diseases may exist in the same person. Others again believe that there is one poison, and that the soft sore is produced by the contagious products of peculiar forms of inflammation occurring in syphilitic sores, which do not contain, at the moment, the specific virus of syphilis, or in which the specific virus is prevented from developing by the inflammation which has been set up by the other contagious products, or in which, it may be, the recipient is proof against specific contagion, and therefore no constitutional symptoms can arise. Again, there are others that believe that the soft sore has nothing to do with syphilis at all.

Without entering into any controversy on this subject, which would serve no good purpose in this place, I shall content myself with adopting the last of these views, and consider the two diseases as entirely separate and distinct from each other.

LOCAL CONTAGIOUS CHANCRE

The **local contagious chancre, soft** or **non-infecting** sore (*chancroid* of the French writers), is almost always situated on the genitals. This is easily accounted for, as it is merely the discharge from the sore which is contagious, whereas in the infecting chancre not only is the discharge from the sore contagious, but also that from secondary sores, or the secretions from the mouth or even the blood, so that other parts of the body where there is a slight abrasion of the skin may be infected from these sources. The soft sore is always produced by inoculation with the discharge from another sore; and if the discharge from this sore is inoculated into another part of the same person a second sore will be produced; again from this second sore a third may be produced, and so on through a regular series. Each sore thus produced will, however, be rather smaller and less characteristic than the one from which it was inoculated, until at last the virus has become so attenuated that it is no longer capable of producing a sore. But the patient is not by this rendered immune to the poison, for if some fresh virus is obtained from a new source the same series of experiments may be repeated.

The soft sore presents three principal varieties: (1) The simple sore. (2) The phagedænic sore; and (3) The sloughing sore.

1. The **simple sore** may appear at any time after connection, most commonly within a day or two. It may begin either in an abrasion or

excoriation produced at the time of connection, or as a vesicle; which soon becomes pustular and then ulcerates. It is very often multiple, and is most usually situated in the sulcus between the glans penis and the prepuce; frequently it commences as an abrasion of the frænum, which it may destroy. It is usually circular in shape, with an abrupt margin and defined sharp-cut border, as if a piece of tissue had been punched out; the surface of the sore presents a grey, unhealthy appearance, and discharges pus. There may be or there may not be induration; if there is, it is not the hard, defined induration of the Hunterian chancre, but is due to inflammatory infiltration. The condition is frequently attended, though not invariably, with inflammatory enlargement of the glands in the groin, which usually runs on into suppuration. The pus from these suppurating glands is contagious, and if inoculated will produce a soft sore at the seat of inoculation. Occasionally the inflammation from the sore extends to the prepuce, causing phimosis; this condition, however, is more frequently the result of the sloughing variety.

The soft sore, if untreated, may run on indefinitely, but under the influence of treatment it usually heals in a week or ten days. The surgeon, however, should ever have present in his mind the fact that a twofold inoculation may take place, and that the soft sore may be merely introductory to the hard; he should, therefore, never give a confident opinion as to the local nature of the sore, as to the rapidity of its healing, or the improbability of the occurrence of secondary symptoms, for he may find, instead of the sore healing in a week or ten days, as he had predicted, that it will continue to discharge, that its edges will present true induration, and a typical Hunterian chancre will after a time evolve, and be followed by secondary syphilis.

The **treatment** of the soft sore is simple; strict cleanliness and some antiseptic powder is all that is necessary. The patient should be instructed to bathe the part night and morning with a little Condy's fluid (ʒi to Oj), and then sprinkle it with a little crystalline iodoform, the smell of which may be disguised by the addition of coumarin (*Iodoformum aromaticum*, Martindale), and the part then covered with a small piece of cotton wool, which may be retained in position by allowing the prepuce, which has been retracted for the dressing, to come forwards over the glans.

2. The **Phagedænic sore** is characterised by a tendency to erosion and destruction of the parts which it invades. It is in its typical form a true eroding ulcer, though sometimes the process may be so rapid that sloughs may be formed. It varies much in its rate of progress, being sometimes slow, sometimes rapid, but it is always obstinate and difficult to arrest. When it advances slowly it gradually undermines and erodes the tissues, healing in one part as it advances in another, and so forming a true serpiginous ulcer. In this way it may destroy the end of the penis, open up the urethra and produce an intractable fistula, or in women destroy the recto-vaginal septum. It occurs generally in the debilitated and broken-down in health, and may attack either the soft or the hard sore. As a rule the ulcer presents an irregular form, with sharply cut edges, where it is spreading, and is accompanied by a foul-smelling, blood-tinged discharge. There is usually considerable pain and very often a certain amount of constitutional disturbance.

Treatment.—The phagedænic ulceration of a chancre may usually be checked by the local application of iodoform, combined with tonic treatment, change of air, a generous and nutritious diet, and regulation of the digestive organs. Mr. Hutchinson advises that the patient should be made to sit in a warm bath for several hours daily, the water in the bath being constantly changed and, if thought advisable, charged with some antiseptic, as boracic acid; iodoform being applied during the intervals between the baths. Others have recommended one or two free applications of fuming nitric acid to the part; this will usually stop the phagedæna, but the treatment is unnecessarily severe, and as equally good results may be obtained by milder means, it is not usually called for.

3. The **sloughing sore.**—The third form of soft sore is the gangrenous. It usually occurs in those that have a long and tight prepuce, and is therefore in a great measure the result of want of cleanliness; that is to say, a patient with this condition of prepuce contracts an ordinary soft sore, and neglecting to carefully get rid of the discharge by syringing, this is retained, undergoes putrefaction, and sets up the condition of gangrene. It occurs most frequently in weak and debilitated subjects; those who have been suffering from want of proper food; soldiers whose health has been undermined by hard service or exposure; men whose constitutions are shattered by habitual intemperance, or prostitutes who are broken down by want and debauchery. It is said also to occur more frequently in the tuberculous subject.

In the male the end the penis becomes enormously swollen, the skin dusky red and glazed, and the prepuce cannot be retracted. In the centre of this red, swollen tissue a black spot appears, which rapidly spreads, until the whole of the prepuce is a fœtid gangrenous mass, and is thrown off in the form of foul pultaceous sloughs. There is a discharge of very offensive blood-stained pus. Accompanying this local condition there is considerable constitutional disturbance of an asthenic type, due to septic poisoning. As soon as the sloughs separate and the pent-up discharges find an exit, the intensity of the inflammation diminishes and the fever lessens. Not only may the prepuce be destroyed in this way, but also the glans penis, and the sloughing process may extend into the corpora cavernosa, opening up the vessels and causing severe hæmorrhage, which may prove fatal; or death may occur from exhaustion. In these cases the glands are not generally affected.

Treatment.—The treatment of this condition must be prompt and energetic. The prepuce must be at once slit up in order to relieve tension and lessen the intensity of the inflammation. When this has been done it is usually at the same time desirable to remove the whole of the prepuce, if the tissues where it joins the body of the organ are not involved, otherwise a pendulous flap of skin will be left, which will require subsequent removal. No formal circumcision can be performed, but the prepuce should be simply cut away with scissors and the part then sluiced thoroughly with 1 in 20 solution of carbolic acid and dressed with wet cyanide gauze and jaconet. If, on slitting up the prepuce, the glans penis is also involved, or if the patient is in an exhausted condition, so as to be unable to stand the hæmorrhage of the major operation, which is generally pretty considerable, the parts should be left and the sloughs allowed to separate of themselves, iodoform being freely applied; any pendulous flaps that may be left being removed on a future occasion. The patient should be treated generally by free doses of opium, plenty of nutritious food and a liberal allowance of stimulants.

In *women* soft chancres present no essential difference from those in the male; they may be either simple, phagedænic, or sloughing. They are most usually found just at the entrance to the vagina on the inner surface of the nymphæ. The irritation that they produce frequently causes considerable swelling and œdema of the loose connective tissue of the labium of the side on which the chancre is. The simple sore presents the same punched-out appearance as in the male, and is to be treated in the same way by cleanliness and the local application of iodoform. The particular point in the treatment is the application of a piece of lint or wool between the labia, so as to prevent the ulcerated surface coming in contact with the labium of the other side.

SYPHILIS

Syphilis is a constitutional condition due to the introduction of a specific poison, and, as we have already stated, there is very good ground for believing that the virus of syphilis is a micro-organism. Lustgarten has described a curved rod-shaped body, which he believes to be the bacillus of syphilis, but it has never been cultivated, and all inoculation experiments with it have failed, so that it cannot be said that the etiology of the affection has been proved, though Lustgarten found the microbes in sixteen cases of syphilis which he examined and also in a periosteal gumma in a case of congenital syphilis. They were absent in two cases of soft chancre which he also examined.

Stages of syphilis.—It is customary to speak of the local phenomena resulting from the inoculation as *primary syphilis*, and the sore which is produced as a *hard* or *Hunterian chancre*: the general symptoms which shortly follow, when the whole blood is infected, as *secondary syphilis*; and certain remote symptoms, which appear at various periods after the secondary syphilis has passed away, as *tertiary syphilis*.

Primary syphilis.—Acquired syphilis can be conveyed from one person to another only by contagion, that is by direct contact of surfaces, and is most frequently communicated by the venereal act, but it can be communicated by direct contact when any part of the surface of the body of the recipient on which there is a slight abrasion, or where the tissues exposed to the contagion are thin and delicate, is brought into contact with the blood, secretions, or discharges of a person affected with the disease.

In cases of inoculation during connection it is not necessary that there should be an abrasion; the delicate epithelium which covers the glans penis allows of inoculation without any breach of surface, but probably no inoculation can take place through the thicker epidermis of the skin without some solution of its continuity. It is probable also that in most cases where the male is infected during sexual intercourse it is from some secondary lesion on the part of the female, such as a mucous tubercle or condyloma, and not from a primary sore, which generally heals very rapidly, though of course it is contagious while it lasts.

After the inoculation, there is a period of incubation before the appearance of the first signs of the disease. The duration of this period is about four weeks, but it is subject to considerable variation, the first signs sometimes appearing at the end of the second week, sometimes being protracted as long as six weeks. Berkeley Hill stated that in thirty-seven cases of experimental inoculation the incubation period averaged twenty-four days.

The first thing which usually draws the patient's attention to the part is intense itching, and on examination a little papule at the seat of inoculation may be found; this increases, becomes somewhat button-shaped and hard, with clearly defined margins. The epithelium covering it then disappears, and an exposed raw surface is established. It now forms a slightly cup-shaped, rounded mass, distinctly circumscribed, which can be pinched up between the finger and thumb, and feels like a button of cartilage with a depressed centre. The tissues around this circumscribed mass are apparently perfectly natural and free from any implication in the disease. The discharge from the surface is very slight, and if the sore has not been irritated by dressings, friction, or such like, on examination under the microscope it will be found to consist of epithelial débris in a clear fluid; no pus cells will be discoverable; but if the sore has been irritated, then pus corpuscles can be found. This is the true Hunterian chancre; but every specific chancre does not present these appearances, sometimes the sore is the prominent feature, and the induration does not extend beyond it; that is to say, there is only induration under the base of the sore and not around it, and in some cases it is very slight. It has been compared by Ricord to parchment. Between this condition and the true Hunterian chancre are found a series of gradations, but in all there is a certain though varying amount of induration. The number of chancres in any given case depends upon the number of points of inoculation; in most cases, therefore, the sore is single. In this respect the chancre resembles vaccination, where a vesicle is formed at each point of inoculation. In another point it also resembles vaccination, and that is, that as soon as the period of incubation is over and the local manifestations of the disease appear, no further result can be obtained by inoculating the patient.

It will be seen, then, that the main difference between the hard and soft sore is the presence of induration in the former and its absence in the latter, at all events in the characteristic form in which it occurs in the Hunterian chancre. In the soft sore there is a process of true ulceration; and the discharge from the surface is true pus; any induration that there may be is merely inflammatory exudation and the tissues are infiltrated with leucocytes. In the hard sore there is the formation of a new tissue at the seat of inoculation which produces the induration, and consists of small round cells, with some large multinucleated cells, which to some extent resemble the giant cells of tubercle, but are more regular in outline. Within a very short time after the appearance of the hard sore the neighbouring inguinal lymphatic glands become enlarged, and can be felt under the skin as hard, bullety, almond-shaped bodies. They are quite isolated from each other, freely movable, and there is no inflammation of the structures around.

The greater proportion of infecting chancres in the male occur on the delicate epithelial surface of the glans penis or the inner aspect of the prepuce. The most frequent situation is in the retro-preputial fold, especially on its under surface at the frænum. They are also not uncommon around the meatus urinarius, but chancres in the canal itself are rare. In the female, chancres are most commonly found on the inner aspect of the labia minora; they are not unfrequently concealed between the rugæ of the mucous membrane, and may escape detection unless a most careful examination is made. They occur sometimes on the cervix or os uteri; but rarely if ever occur on the lining membrane of the vagina. In addition to these, the common sites of chancre, they may, of course, occur anywhere where the syphilitic virus is accidentally inoculated. Thus they are not uncommon on the nipple of the wet-nurse, who suckles a syphilitic infant, or on the lips or tongue from smoking the pipe of a syphilitic individual, or from kissing when there is an abrasion on this part (fig. 38). Again, chancres have been caused by tattooing, by vaccination, or by bites from syphilitic persons. And, finally, surgeons, accoucheurs, and nurses are occasionally infected, during the dressing of a venereal sore, or the delivery of a syphilitic woman.

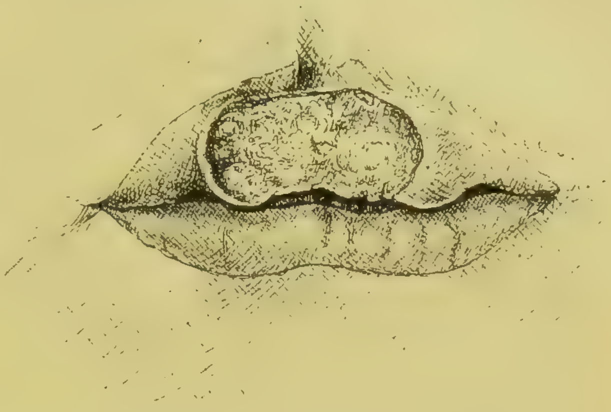

FIG. 38.—A chancre on the lip. (From a drawing in the Museum of St. George's Hospital.)

The **diagnosis** of a typical Hunterian chancre is not as a rule difficult, but when the specific virus is combined with other products and a mixed sore is produced the diagnosis becomes more difficult, and under these circumstances herpes, epithelioma, and gummatous ulceration have all been mistaken for chancre. Especially is this so with that form of gummatous deposit which has received the name of 'relapsing chancre,' and which is nothing more than a gumma at the site of an old chancre in a syphilitic individual.

Perhaps a point of more interest and certainly of much greater difficulty is the diagnosis between the hard and soft sore, and this in many cases is impossible until the advent of secondary symptoms solves the difficulty. Certain diagnostic points have been laid down, as, for instance, the character of the induration, the non-purulent nature of the secretion in the hard chancre, and the nature of the enlarged glands; but all these tests are fallacious, because the two conditions may co-exist, and what was originally a soft sore may become a hard one; because the hard sore if exposed to any irritation can be made to suppurate; and finally because the amount of induration in a hard sore may be so slight as to deceive the surgeon. The greatest caution must be observed, therefore, on this point, and in most cases it is wiser to tell the patient that you are unable to give him any information as to whether he will have secondaries or not, that time alone can reveal it.

Treatment.—With regard to the treatment of primary syphilis, a difficult problem has often to be solved. If there is no doubt about the diagnosis, that the case is one of Hunterian chancre, there can be no doubt about the treatment. Mercury should be at once given, and it will be found that this is the best means of healing the sore, getting rid of the induration, and diminishing the severity of the secondary symptoms, in addition to commencing the plan of treatment which is necessary to eliminate the poison from the system. But in those cases where there is a doubt as to the diagnosis, the line of treatment is by no means so positive, for if the sore is a non-infecting one, by adopting the plan of giving mercury we expose the patient to a course which is quite unnecessary and cannot do him any good. If, after the most careful examination of the patient, no positive diagnosis can be arrived at, I believe that it is right to withhold mercury until some definite symptoms declare the true nature of the case, but that as soon as a positive diagnosis of syphilis can be made, mercury should be given.

It is occasionally recommended that an indurated sore should be excised or destroyed by the actual cautery or fuming nitric acid, but the cases in which this can do any good must be very few. The induration itself denotes that the system has already been contaminated, and that the disease is too far advanced to hold out any hope of curing the disease by local measures.

Cases where it is determined not to commence mercury at once should simply be treated, as indeed all cases should be treated, by local measures applied to the sore with a view to promote its healing. This consists in perfect cleanliness, and the avoidance of any source of irritation. Probably a piece of lint soaked in black wash is as good an application as any other, or the part may be covered with a little boracic acid ointment.

The best mode of administering mercury is still a matter of considerable difference of opinion. There is no question that the most convenient method is by the mouth, but it has the disadvantage of sometimes disturbing the digestive organs and causing purging. This can, however, usually be avoided by the addition of a little opium; and as a matter of practice, it will be usually found that mercury is given in this way. It is convenient generally to give it in the form of a pill, which can be easily carried about in the patient's pocket, and taken without observation. Many preparations of mercury have been advocated at different times, but perhaps the most useful are grey powder, blue pill, and perchloride of mercury. Of these the grey powder is the most generally used. A pill containing grey powder (gr. j) and Dover's powder (gr. j) is made with extract of gentian, and given from three to six times a day. Or blue pill may be used instead of grey powder, but it is more likely to purge the patient. Blue pill (gr. 2), quinine (gr. 2), ext. hyoscyam. (gr. ½), may be made into a pill, and given three times a day. The perchloride of mercury is exceedingly useful, and appears to act more rapidly than the metallic mercury, and can be conveniently combined with iron in anæmic subjects. Perchloride of mercury (gr. i), reduced iron (gr. xvi), may be rolled into a mass with sufficient extract of gentian and divided into sixteen pills, one of which may be given three times a day. The above-mentioned doses may require regulating; some patients stand mercury better than others, and during the first few weeks of the administration the effects of the drug should be carefully watched, and variations made until the appropriate dose is determined for the individual case; after this the prescription may remain unchanged for weeks.

The other modes of administering mercury are by the skin or by injection, but the inconveniences of this mode of administration are so great, that it will generally be found that it is of advantage to employ them only in those cases where the mercury cannot be taken by the mouth, on account of the irritability which it produces.

The method by *inunction* is the one most to be advocated, and is the plan of treatment which is usually followed at Aix-la-Chapelle, a place which has gained a certain notoriety for the treatment of syphilis. Half a drachm to a drachm of the mercurial ointment (B.P.) is well rubbed into some part of the body daily, those parts of the body being selected where the skin is thin and contains few hairs, so that the ointment may be rapidly absorbed, and a fresh part of the body being selected for each day's rubbing, in order to avoid setting up dermatitis. The advantage of this plan of treatment is that it rapidly brings the patient under the influence of the mercury; but it is a dirty method, and possesses this distinct disadvantage, that absorption of mercury still goes on after the rubbing has been discontinued, from the ointment collecting in the hair follicles and sweat glands, so that salivation sometimes occurs without the surgeon being able to prevent it.

The other method of giving mercury through the skin is by calomel fumigation. The patient is seated naked on a cane-bottomed chair, and is enveloped in a mackintosh cloak which covers all his body but the head and face, and the chair on which he is seated. Beneath the chair is placed an apparatus by which calomel is volatilised in the presence of the vapour of water. The combined vapour surrounds the patient's body, and the calomel is deposited upon it in the form of a white powder. After all the calomel is sublimed the patient goes to bed, wrapped in a blanket or the cloak which he has used for the bath, and without rubbing the powder off his body. This plan of treatment, extensively employed some thirty years ago, is now, I believe, rarely resorted to.

The plan of treatment by injections is still recommended by some surgeons, but is never likely to be extensively employed; in the first place on account of the difficulty of graduating the dose, and secondly because the plan of treatment is not altogether devoid of risk. Many mercurial preparations have been advocated for the injection, but the two best would appear to be a solution of perchloride of mercury or a solution of sal alembroth, a double chloride of mercury and ammonium. One-third of a grain of either drug is dissolved in a few drops of water and injected into the muscular tissue of the buttock once a week. Care must be taken to preserve strict asepticity,

Recently the treatment of syphilis by intravenous injection of cyanide of mercury has been advocated. It is claimed for this method that the patient is rapidly brought under the influence of the drug, and that the exact quantity of mercury introduced into the system is known. It is said to be especially useful in cases which have not responded to the ordinary methods of treatment, such as pills, inunctions, &c. The operation is performed as follows: the bend of the elbow is rendered surgically clean; a bandage is applied to the upper part of the arm and a fine needle of a hypodermic syringe, containing 20 minims of a 1 per cent. solution of cyanide of mercury, is thrust into the vein. The bandage is then removed and the fluid injected. The needle is withdrawn, and pressure is maintained for a few minutes with an aseptic pad. The injection is repeated every morning.

The action of mercury is rendered much safer and more speedy by keeping the patient in bed, but of course this can rarely be done. The patient should be cautioned, however, to avoid catching cold by exposing himself to sudden changes of temperature, getting his feet wet, &c. He should live regularly, take simple abundant food, and avoid any alcoholic excesses. It is unnecessary to produce salivation, in fact it is wrong to do so: the patient's gums should be carefully watched, and as soon as the slightest sponginess appears, the mercury should be stopped for a day or two, and then resumed in diminished doses so as to keep the gums in this condition, just on the borderland of sponginess. The treatment should be kept up certainly for twelve months, probably two years is better, with slight intermissions now and then, especially if the patient begins to lose weight.

It will sometimes be found that, owing to some idiosyncrasy, a patient appears to be intolerant to mercury, and in some instances it will be found impossible to give it ; but it is a curious fact that, though a patient may not be able to tolerate the drug when administered in one way, he will be found able to bear it when given in another. When, therefore, a case of this sort is met with, the use of the remedy should not be abandoned until the different measures mentioned above have all been tried : a patient who cannot tolerate the drug when given by the mouth, may very well bear it when administered by inunction or injection. But there are some cases in which mercury requires to be given with extreme caution, especially patients who are suffering from albuminuria. I have seen eight grains of grey powder profusely salivate a patient with granular kidneys. Then, again, patients who are in a condition of great debility, particularly tuberculous individuals, bear mercury very badly, and it must be given with caution ; also patients exhausted by dissipation or insufficient food are not good subjects for mercury, and it must be given in very small doses and the effects carefully watched.

In cases where mercury cannot be given, the only plan of treatment is to improve the general condition, and give such remedies as iodide of potassium, ammonia, sarsaparilla, &c., but no drug except mercury can be said to exert any real influence on the disease.

Secondary syphilis.—The secondary symptoms of constitutional syphilis do not usually appear until the primary sore has healed, which it commonly does in about six weeks, if it has not been irritated by caustics, &c. ; but though the sore has healed, there will probably be some induration still remaining. The usual time for the appearance of the first secondary symptom, which is usually an eruption of the skin, is about eight to twelve weeks from the time of inoculation, though the period may be longer, especially if the patient has been given mercury at an early period after the first appearance of the sore.

Shortly before or at the time of the first appearance of secondary symptoms, in a considerable number of cases, the patient suffers from certain febrile symptoms, which are sometimes termed 'syphilitic fever.' The patient feels ill and out of sorts, he complains of headache, pains in the bones, and aching in the loins ; there is a slight nocturnal elevation of temperature, with increased frequency of the pulse, and a furred tongue. But these symptoms are by no means constant, and it is certain that many cases of secondary syphilis occur without these premonitory symptoms.

The parts which are principally affected in secondary syphilis are the skin and its appendages, the mucous membrane of the mouth and throat, the eye, and the lymphatic glands.

1. **The skin.**—In most cases the first evidence of secondary syphilis is the appearance of an exanthematous rash, (1) *roseola*, which is not unlike measles. It generally appears on the chest and abdomen ; it is very transient, often fading in twenty-four hours or so, and frequently escapes observation, especially in hospital patients ; (2) later on, a papular rash, *lichen*, appears in many cases. It consists of small papules, produced by the effusion of inflammatory material into the dermis. Frequently the epithelium over these papules desquamates and forms a thin dry scale, thus giving it the appearance of a squamous eruption ; to this the term

psoriasis or *papulo-squamous syphilide* is applied. (3) Still later, a tubercular eruption may appear, especially occurring on the face. To this the term *acne* is sometimes given, but the term is a bad one if the word acne is restricted to an affection of the sebaceous follicles, and the term *tubercular syphilide* more correctly expresses the condition. Pathologically it is identical with lichen, and differs only in degree, the inflammatory infiltration of the skin taking place in larger masses. These are the more common eruptions in syphilis, and occur at the earlier stages of the disease. Those which occur less frequently and at a later period are: (4) Vesicular eruptions, which are very rare. (5) Pustular eruptions, which are more common. The pustule dries and forms a scab, which after a time falls off and leaves no scar behind it. (6) Bullous eruptions, which consist of large bullæ or blebs, filled with serum, which soon suppurate and burst; the discharge dries on the surface and forms a scab; beneath this a further secretion takes place, which goes through the same process, and forms a second scab of rather larger size; by a repetition of this process a dark-coloured pyramidal scab is formed, which resembles a limpet shell. To this form of syphilitic eruption the term *rupia* is applied (fig. 39). After a time the scab falls off, leaving a circular ulcer, which tends to heal from the centre. Rupia occurs usually as a late secondary; when it occurs at an early stage of the disease it betokens a serious condition, as it only arises at this time in the debilitated and worn-out individual, and the prognosis in these cases is never good, as the patients bear mercury badly.

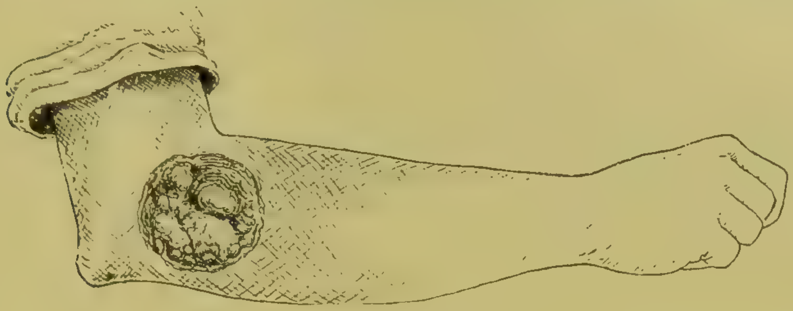

FIG. 39.—Syphilitic rupia. (From a drawing in the Museum of St. George's Hospital.)

Though these eruptions for the sake of clearness have been described independently of each other, it must be understood that they do not occur as isolated eruptions in any given case of secondary syphilis, but that one of the great and leading characteristics of the syphilides is their polymorphism; that is to say, they are not limited to one type, for in the same patient there may be seen papules interspersed with a scaly eruption or with tubercles, and as these eruptions are merely modifications of the same pathological process, this is not to be wondered at. The other leading characteristics of syphilitic eruptions are their colour, which is often described as being coppery, but more correctly as being of the colour of lean ham. A third characteristic is the absence of any itching or local discomfort. They are fairly symmetrical, and especially affect the flexor aspect of the limbs and the front of the chest and abdomen. They have a tendency to fade away and disappear after a few weeks or months if left untreated, and to disappear rapidly under the internal administration of mercury.

Some of these syphilitic eruptions may be modified by the position in which they appear. If, for instance, the papular or tubercular syphilide appears in some situation where the skin is habitually moist, as around the anus, or on the vulva or scrotum, or at the corners of the mouth, the papules or tubercles become converted into a flat, raised oval surface, which is smooth and covered with a whitish false membrane, and secretes a thin fluid, which is infective and is probably a fertile source of syphilitic infection. These bodies, which are termed *condylomata*, when situated on the vulva are probably much more frequently the source of the infecting virus than the original chancre, which, as we have seen, usually heals rapidly in the female. These condylomata sometimes appear between the toes, when they are prone to ulcerate and form deep cracks or fissures, which discharge a very offensive fluid; to these the term *rhagades* is applied. They usually result from the want of proper cleanliness.

A similar condition to condylomata will be described as occurring on the mucous membrane of the mouth.

Before leaving the subject of syphilitic diseases of the skin, we must allude to the disease as it affects its appendages.

The hair of the head frequently becomes thin, coming away in large quantities during combing, and in rare cases the patient may become completely bald, and at the same time the beard and the eyebrows may disappear. In other cases the baldness is in patches. The hair usually grows again after a mercurial course, and the patient may have as luxuriant a crop of hair as ever.

The nails may become affected. Usually there is merely a little roughening and longitudinal striation, but sometimes one or more nails may separate from inflammation of the matrix. In other cases, again, the nail becomes greatly thickened and its layers heaped up one on another, producing an appearance like an oyster shell. This is sometimes known as psoriasis of the nail, and may occur as a non-syphilitic affection. Finally, in the latter stages of secondary syphilis, an ulceration of the matrix of the nail may take place, and the nail may be thrown off and leave an ulcerated surface behind. This condition resembles onychia maligna, but there is not the same fœtid discharge.

2. **The mucous membrane of the mouth and throat.**—The mucous membrane of the mouth and throat especially, but also the mucous surfaces in some other parts of the body, are the site of several different lesions in different stages of syphilis. The first of these, which occurs about the same time as the exanthematous rash, is slight ulceration of the tonsils. The ulcers are usually symmetrical, somewhat horse-shoe in shape, and present a greyish white surface. They are often painless, and frequently disappear in a short period of time. In other cases the tonsils and the rest of the mucous membrane of the throat are red and congested, without ulceration. A little later on *mucous patches* appear in the mouth, especially on the mucous membrane of the cheek. These are identical with the condylomata which occur on moist skin, and present the appearance of a slight flattened elevation of a greyish white colour. These mucous patches may occur on other mucous surfaces besides that of the mouth, as on the vulva of women, or under the prepuce in men. Somewhat later in the secondary stage, excavated ulcers may form on the tonsils; they have sharply cut edges, with some redness of the mucous membrane around, and a grey, sloughy looking surface; or, again, ulcerated patches or fissures may form at the commissures of the lips. The tongue is also

frequently affected in this stage of the disease: bald patches caused by destruction of the papillæ may sometimes be seen, and, again, in other cases the opposite condition, hypertrophied papillæ, causing little warty growths which are for the most part located in the centre of the tongue, just in front of the circumvallate papillæ. Mucous patches are also frequently to be seen on the dorsum of the tongue.

Occasionally syphilitic ulcers about the mouth and throat are exceedingly intractable; this may sometimes be due to excessive smoking, or to the injudicious administration of too much mercury, or, when they occur on the tongue or cheek, to the irritation of a jagged stump of a tooth; but in addition to the persistence of ulceration from these causes, cases occur in which, without any assignable reason, these ulcers may prove very intractable and slow to heal. The ulceration sometimes assumes a phagedænic form; starting, say, from the tonsil, it may invade the soft palate or the pharynx, and lead to extensive destruction of tissue. It occurs in the later stages of secondary syphilis, and is said usually to accompany the rupial eruption.

3. **The eye.**—Of the affections of the eye in secondary syphilis, *iritis* is by far the most common. Other conditions, such as choroiditis and neuro-retinitis, are very rare conditions which are said to occur in secondary syphilis; if so, it is quite in the later stages, and they appear to belong more properly to the intermediate condition, which is sometimes present, between the secondary and tertiary stages.

Syphilitic iritis always arises in the secondary stage of syphilis, and generally occurs between three and six months after infection. It generally only attacks one eye, but the other one may suffer subsequently, in spite of successful treatment of the first. The symptoms of this affection are discolouration and irregularity of the iris, and partial or complete immobility of the pupil; a circum-corneal zone of congestion; a varying degree of photophobia, and circum-orbital pain. The discolouration of the iris is due to its infiltration by inflammatory products, and in some cases the lymph effused is deposited in little nodules on the surface of the iris, a characteristic sign of the syphilitic form of the disease. The irregularity and sluggishness of the pupil are due to adhesions, and the former is often much increased by the use of atropine. The diagnosis of the disease from the rheumatic form of iritis is made by the history of the case and the presence of other syphilitic lesions, and by the fact that in this form the congestion and photophobia are less than in the rheumatic, and that there is no haziness of the cornea.

4. **The glands.**—Enlargement of the superficial lymphatic glands is of very common occurrence during the stage of secondary syphilis. We have already seen that the oblique chain of glands along Poupart's ligament may become enlarged during the primary stage, but not only does this enlargement persist during secondary syphilis, but other glands in different parts of the body also become enlarged. Those lying along the posterior border of the sterno-mastoid are the ones most frequently affected, but others, such as the sub-occipital glands, those in the anterior triangle of the neck, the gland in front of the internal epicondyle of the humerus, and the vertical chain of glands below Poupart's ligament, are also very commonly enlarged, and there seems good ground for believing that some of the deep lymphatic glands are also affected. The enlargement is never very great, but the glands can be felt forming a chain of hard, knotty tumours under the skin; they are freely movable, separate from each

other, and generally somewhat almond-shaped, hence they are sometimes known as *amygdaloid glands*. They are generally quite painless.

Amongst the rarer lesions of secondary syphilis are periostitis, affections of the joints, the ear and the testicle. The **periostitis** does not give rise to the formation of nodes as in the tertiary form of the disease, but there is merely pain complained of, which is increased on pressure, and is sometimes attended by a little swelling. The **joint affection** is a sub-acute form of synovitis, attended by pain, which is worse at night, and is often very intractable. The **affection of the ear** is a deafness which is supposed to be due to some morbid condition of the internal ear, but about which little or nothing is known. In most cases the deafness is slight and passes off rapidly under the influence of treatment, but now and then cases occur in which absolute deafness comes on with great rapidity. The **affection of the testicle** belongs more to the intermediate stage, with which it will be considered.

Usually patients suffering from syphilis pass through the secondary stage without any grave disturbance of the general health. But occasionally cases are met with where the opposite is the result ; the patient becomes anæmic, with loss of appetite, inability to sleep and general emaciation. In these cases the amount of prostration &c. is out of all proportion to the severity of the local condition.

Treatment.—The treatment of secondary syphilis is the same as that of the primary disease, namely mercury. If the nature of the primary sore has been recognised and the patient placed under a course of mercury, it must be continued in that form and in that dose which has been found best suited to the patient's requirements. If, on the other hand, the treatment by mercury has not been commenced, as soon as the first symptoms of secondary syphilis show themselves, the drug should be ordered and given for the length of time mentioned in speaking of the treatment of primary syphilis. There are one or two points about the treatment of special forms of secondary symptoms to which allusion should be made. The skin eruptions require no special reference, except to mention that in those cases where rupia occurs at an early period of the case mercury requires to be given with great discrimination and care ; and I have found that patients belonging to this class bear mercury very badly when given by the mouth, and that the best way to administer it is by fumigation, using very small doses (say, 5 grains) of calomel and combining with this careful feeding, a moderate allowance of stimulants and tonics, with small doses of opium. The combination which I have found most useful is the compound decoction of sarsaparilla, with steel wine and laudanum, in 5-minim doses three times a day.

In throat affections, some local treatment is generally advisable. A gargle of alum or chlorate of potash is generally all that is necessary for the superficial ulcerations of the earlier conditions of the secondary stage. In the later conditions, where excavated ulcers form on the tonsil, there is nothing that has proved so useful in my hands as the verdigris gargle of the St. George's Hospital Pharmacopœia. This is composed of verdigris gr. xv, vinegar ʒiss, honey ʒiij, and lime water Oj. When the ulceration assumes a phagedænic form, the local fumigation with calomel seems to be the most potent means of arresting the destructive process. This is administered in the following way : ten, fifteen, or twenty grains of calomel are placed in a common earthenware teapot and the lid closed. A spirit lamp is then held under the teapot until the calomel is sublimed. The patient puts his lips to the spout of the pot, and cautiously sucks the vapour into the mouth, so that it is brought into contact with the ulcerating surface. This must be done with care, as a vigorous inhalation would carry it into the air passages and excite a severe attack of coughing. The mucous patches which occur in the mouth are best treated by painting them over with a solution of chromic acid (gr. x ad ℥i), or a solution of nitrate of silver (gr. xx ad ℥i), every second or third day. The solution of chromic acid especially is of the greatest service, and often succeeds in getting rid of these patches in a surprisingly short space of time. Syphilitic iritis must be treated with atropine, in addition to the mercurial course, in order to secure dilatation of the pupil. Two or three drops of a solution of atropine (gr. iv to the ℥i) should be inserted into the eye every four or six hours until this end is attained. The affected eye should be protected from light during the acute stage, and a blister applied to the temple, if the pain is very acute.

The treatment of the other forms of secondaries requires no special mention.

Tertiary syphilis.—The division of syphilis into stages is to a great extent artificial. The distinction between the primary and secondary stage is definite, but the same cannot quite fairly be said about the secondary and tertiary stages in all cases.

Tertiary syphilis is said to be distinguished from secondary by the occurrence of an interval of health. A patient contracts syphilis, he passes through the primary and secondary stage, and after a time all symptoms, either under the influence of treatment or without it, disappear, and he is apparently quite well, and remains well for a longer or shorter period of time. Then other symptoms supervene: the patient has got *tertiary syphilis.* Such a case as this is perfectly clear, and there is a definite distinction between the two conditions, secondary and tertiary syphilis. But this does not always occur. It may and frequently does happen that before the secondary stage is over, certain symptoms arise and may be prolonged until after the tertiary stage has begun, so that there is no interval of immunity between the two stages. To this condition Mr. Hutchinson has given the name of *intermediate stage*, and the symptoms which occur during it he call *reminders.* But though we cannot exactly differentiate between the secondary and tertiary stages, there are certain characteristic differences between the two conditions which make their separation a matter of practical clinical importance.

With regard to secondary symptoms there can be no question that their duration is limited, and that they have a tendency to disappear spontaneously and quite independently of any treatment which may have been adopted. This is not so with the tertiary symptoms; the condition once started goes on indefinitely unless arrested by medical aid. Then, again, in secondary syphilis there is a certain well-defined symmetry, which is almost unknown in the tertiary form of the disease. And thirdly, in tertiary syphilis, in the majority of cases, the tendency is towards the production of definite formations, *gummata.* It is in fact, as Lancereaux puts it, the 'stage of gummatous products.' This new growth resembles the products of inflammation regarded as an ulcerative process; while in secondary syphilis the new growth, when it exists, resembles more the product of inflammation regarded as a reproductive process.

The **intermediate stage.**—This so-called stage resembles more a condition of relapse than a distinct, or even an intermediate stage, as its symptoms resemble to a great extent those noted in the secondary stage of syphilis, and bear little resemblance to those found in tertiary syphilis. The symptoms are generally symmetrical and disappear without treatment, and the patient is still capable of impregnating his offspring, and in these points they differ from tertiary symptoms, which are non-symmetrical, have no tendency to spontaneous cures, and occur when in all probability infection of the offspring is impossible. It seems to me, therefore, that the old term, *late secondaries*, is more appropriate to this condition, than to call it by the name of intermediate stage. The principal forms in which this condition shows itself are :

(1) **Psoriasis palmaris and plantaris.**—It is somewhat of a misnomer to call this condition 'psoriasis,' for, like the so-called psoriasis of the skin in secondary syphilis, it is a papulo-squamous eruption. It consists of papules or nodules—a lichenoid eruption over which the thickened epidermis desquamates and becomes detached in flakes, giving it the appearance of a scaly eruption. It may persist for a long time, indeed until after the tertiary symptoms have appeared.

(2) **Syphilitic sarcocele.**—Another 'reminder' is a slow, painless enlargement of the testicle, with a smooth rounded outline ; generally commencing in one testicle, it after an interval involves the other. Suppuration may take place if it be left untreated, and it may be followed by hernia testis, but under the influence of mercury the enlargement usually subsides.

(3) **Leucomatous patches** on the tongue is another condition often found during this intermediate stage.

(4) Those diseases of the eye, **choroiditis** and **neuro-retinitis,** which have already been mentioned as occurring in syphilis, are usually found during this intermediate stage. They are, however, very rare. These diseases may be diagnosed by the ophthalmoscope.

(5) Mr. Hutchinson believes also that **syphilitic disease of the arteries,** principally affecting the cerebral vessels, and leading to disease of the brain, belongs to this intermediate group.

Tertiary syphilis is essentially an inflammatory condition, attended by inflammatory changes of an unhealthy or degenerate type, which shows itself in different ways : (1) By inflammation of a localised character, attended by the effusion of a considerable amount of inflammatory products, which infiltrate a circumscribed area of tissue, and produce a localised swelling which is called a *gumma*. (2) By a more diffused inflammation, which produces overgrowth of the cellular tissue of the organ or part in which it is located, and leads to fibroid induration and hyperplasia of those organs or parts. (3) By inflammation of the intima of the small arteries, which causes narrowing of the lumen of their tubes, and leads to changes from malnutrition in consequence of imperfect blood supply.

1. A **Gumma,** sometimes called a *syphilitic granuloma* or *syphiloma*, is a circumscribed inflammation, attended by the infiltration of the part inflamed with small round cells, which are in part migrated leucocytes, and in part proliferated connective tissue corpuscles. Amongst these cells new vessels are formed by the growing into the tissue of loops from the surrounding capillaries. The cells gradually destroy and replace the tissues into which they have been infiltrated, and exceeding in bulk the tissues they have replaced, they form a distinct tumour. We have therefore a vascular swelling, consisting of round cells, between which is a fibrillated, intercellular substance, which must be regarded as a mass of granulation tissue.

This increases by fresh infiltration taking place around it, until it reaches a certain size. Then degenerative changes take place in the cells from malnutrition, due, in part, to the pressure which the new tissue exercises on the surrounding blood-vessels, and probably also in part to degenerative changes taking place in the vessels themselves, whereby their lumen is narrowed or more or less completely occluded. The cells undergo fatty degeneration, while the fibrillated structure undergoes little change, and gives a considerable degree of toughness to the mass. This new growth may undergo one of three changes : (*a*) it may be absorbed under treatment, leaving behind a depressed scar in place of the destroyed tissues. (*b*) It may die and form a slough. Around the slough, however, there is always a zone of infiltrated tissue, in which death does not occur, and here ulceration takes place, and the slough is gradually separated. (*c*) It may become encysted and inert. This generally occurs in the internal organs, as the liver or brain ; the caseated mass does not perish, and the zone of infiltration around it undergoes development, and forms a fibrous capsule around the central mass and completely encysts it. It then remains inert, and may gradually undergo a process of calcification.

2. In the **diffuse form of inflammation** in tertiary syphilitic affections the connective tissue of the affected tissue or organ becomes widely infiltrated with round cells, instead of these cells being collected into a small space, as in the gummatous form of the disease. This causes a gradual enlargement of the whole viscus or organ, or of some considerable part of it, and it becomes tougher and firmer than in its natural condition. These round cells become converted into fibre cells and fibrous tissue, and there is thus an overgrowth of the connective tissue of the part, which may press upon and absorb the normal structures, and diminish their natural functions. Later on considerable contraction of this new fibroid material takes place, producing shrinking and puckering of the surface of the affected organ. The condition is principally found in the viscera, the liver, lungs, spleen, and testicle, but also not infrequently in the bones also, leading to a condition of hypertrophy and sclerosis, for in these cases earthy salts are deposited in the newly formed fibroid material, leading to the formation of new bone, and there is no contraction.

3. The **changes in the smaller arteries.**—This is of the nature of an obliterative arteritis, and consists principally in a proliferation of the endothelium of the intima and its infiltration by small round cells, the result of this proliferation. The external coat is, however, thickened to some extent. This collection of cells considerably narrows the tube and may result in complete obstruction of its lumen, thus leading to deficient nutrition with its attendant results. It affects the smaller arteries, especially those of the brain, but does not appear to involve the larger vessels.

We must now consider the individual lesions of tertiary syphilis as they affect different parts.

Tertiary syphilitic disease of the bones.—The bones are very commonly the seat of tertiary syphilis, and it will be convenient to consider this condition in the first place. Syphilitic disease of the bones is merely a modification of the same process which characterises tertiary syphilis in other parts, and presents itself both as the diffuse and circumscribed form. As the *diffuse* form it shows itself as an osteo-sclerosis. There is a gradual enlargement of the bone over a considerable area, perhaps through the whole of the shaft of a long bone, or throughout the vault of the skull. It corresponds to the diffuse outgrowth of fibrous tissue in other parts, but in these cases goes on to the formation of dense osseous tissue, both on the surface of the bone and in its interior, so that the medullary cavity may be entirely obliterated. In other cases we may have the same changes, instead of extending over the whole bone, in a localised portion of the periosteum. It consists in an inflammatory exudation into and under the periosteum, which develops into fibroid tissue and then becomes converted into bone. This is called a *node*, and principally attacks the subcutaneous bones, as the tibia, the sternum, clavicle, and ulna. It is, like the more diffused form, an instance of sclerosing ostitis, and in both there is severe pain of an aching or boring character which is especially great at night.

In addition to this we get in bones the *circumscribed* form of tertiary syphilitic inflammation, resulting in the formation of a true gumma, and this may take place either in the periosteum or the medulla. When it occurs in the periosteum it is not to be distinguished, in the early stage, from the node, just alluded to, but in the later stages it, like gummata elsewhere, degenerates, and eventually dies, forming a slough, whereas the true node has no tendency to suppurate. When gummatous swellings occur in the medullary substance they lead to expansion of the bone. The softening and breaking down of a gumma leads to caries and necrosis, but the condition is not quite an uncomplicated one, for the gummata are almost always associated with a certain amount of sclerosis, and in all probability the death of the bone may be partly due to the obliteration of the Haversian canals, the result of the sclerosing process. Gummata may occur in any bone, but the ones most frequently affected are the bones of the vault of the skull, the frontal and parietal, and the disease may begin on the surface of the bone or in the diploe; in the nasal bones or septum nasi, leading to necrosis and falling in of the bridge of the nose; and in the hard palate, causing perforation. Unlike tuberculous disease, it rarely attacks the cancellous tissue of the short bones.

Tertiary syphilitic disease of the joints is not common; but occasionally a gumma may form in the synovial membrane or capsule of a joint, especially the knee. It is attended by effusion into the joint and pain, especially severe at night. The bursæ are also sometimes the seat of gummatous deposit.

Tertiary syphilitic disease of the muscles.—Gummata are frequently formed in the muscles. They form ill-defined swellings, which slowly go through the process of softening, and are accompanied by much aching pain and tenderness.

Tertiary syphilitic disease of the skin and subcutaneous tissue.—Gummata not infrequently form in the subcutaneous tissue and go through the ordinary course of a gumma elsewhere. They soften, break down, the skin over them gives way, and they extrude a slough leaving an ulcerated surface. They occur for the most part on the lower extremities, but, unlike the varicose or indolent ulcer, they may occur on any part of the extremity. They appear first as an indolent, ill-defined lump, the skin over which becomes after a time of a dusky red colour. The swelling, which at first is hard, becomes soft and fluctuates, and the skin, gradually thinning, gives way and exposes a wash-leather slough, which separates and comes away, leaving an ulcer with sharp-cut, undermined edges, around which is considerable induration. This, under the influence of treatment, heals, leaving a puckered cicatrix. Another tertiary condition of the skin is a form of serpiginous ulceration, which begins as an infiltration of the skin, sometimes commencing as small nodules (? minute gummata), which coalesce and form a reddish brown elevation. This breaks down and ulcerates, leaving an ulcer which is usually somewhat horseshoe in shape, and has a tendency to spread in one direction, while it heals in another. In addition to these affections of the skin, rupia sometimes occurs as a tertiary condition, and forms a limpet-shaped scab, in the manner already described (p. 185), which after a time separates, leaving a circular ulcer which has a tendency to heal from the centre.

Tertiary syphilitic disease of mucous surfaces.—Tertiary syphilitic disease of the mucous surfaces is usually confined to those parts which are situated at the commencement and termination of those tracts which are lined by mucous membrane. Thus in the gastro-intestinal tract tertiary syphilis is almost entirely confined to the mouth and pharynx at its commencement and the rectum at its termination, the intervening portions being seldom affected. So in the respiratory tract, the mucous membrane of the larynx is frequently the seat of tertiary syphilis, but it seldom implicates the mucous membrane of the tract below this. And in the genito-urinary tract, the end of the penis in the male and the vulva and lower part of the vagina in the female may be the seat of gummatous deposits, while it is rare to find them throughout the rest of the tract.

The mucous membrane of the **lower lip** is sometimes the seat of a diffuse gummatous infiltration, which produces thickening and induration of the inner surface of the lip and causes its erosion and an unsightly appearance. This may subsequently lead to contraction and puckering, or else tertiary ulceration may be set up. Inside the mouth the **tongue** is the most frequent seat of tertiary syphilitic disease. We may sometimes get in the tertiary stage the same bald patches which were described as occurring in secondary syphilis; or leucoplakia, going on to psoriasis and ichthyosis, frequently occurs during the tertiary stage and is often the precursor of epithelioma. It may or may not be syphilitic in its origin, and will be described with diseases of the tongue.

Gummata are of very frequent occurrence in the tongue. They are usually situated on the dorsum near the centre, and in this respect differ from epithelioma, which for the most part affects the edges. They form swellings, somewhat ill defined and hard at first, but after a time soft from breaking down of the inflammatory tissue. They burst and give exit to a wash-leather slough, leaving an excavated ulcer with sharp, undermined edges, and considerable induration around (fig. 40). In the **pharynx** gummatous infiltration is very common. This breaks down and leads to tertiary ulceration, which is often of a most destructive character, rapidly eating away in some cases the whole of the soft palate and interfering with deglutition and articulation. It also destroys the mucous membrane of the pharyngeal wall, and after it has healed leads to serious contraction, which may almost or completely occlude the communication of the pharynx with the nasal fossæ, or lead to great stenosis of the lower part of the pharynx and extreme dysphagia. It is said that tertiary ulceration may occur in the œsophagus, leading to stricture of the canal, but this is not common.

The **larynx** is frequently the seat of tertiary syphilitic disease. Gummata are deposited in the mucous tissue, which break down early and are attended by extensive ulceration, which may lead to destruction of the vocal cords or necrosis of the cartilages, and is often followed by stenosis.

At the lower end of the alimentary canal the **rectum** is often the seat of venereal disease. In tertiary syphilis there is sometimes, though not often, an infiltration of the mucous membrane, which produces thickening and contraction, but does not ulcerate; this is known under the name of ano-rectal syphiloma. But in addition to this there is a destructive ulceration, almost exclusively confined to women, which is usually regarded also as a tertiary affection, though there seem some very good grounds for believing that this is not the case. This condition will be described with the other diseases of the rectum.

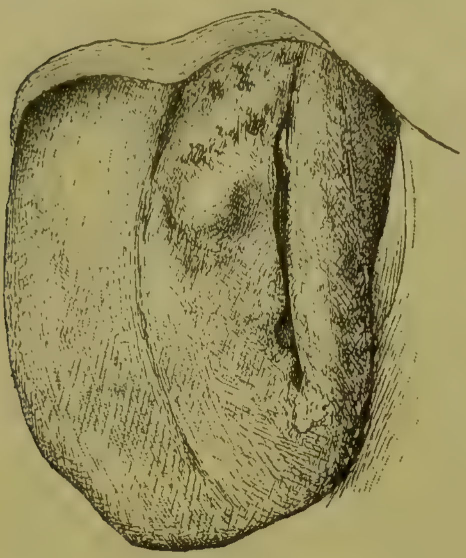
FIG. 40.—A gumma of the tongue. (From a drawing in the Museum of St. George's Hospital.)

The **penis** in the male and the **vulva** and lower part of the vagina in the female may be attacked with gummatous ulceration, and they are liable to be mistaken for primary sores.

Tertiary syphilitic disease of the viscera.—Tertiary syphilis may affect most if not all of the internal organs, and may lead to organic changes of the most serious character. As in other parts, it may show itself either in the diffuse form or as the localised gumma. In the former it produces an interstitial growth of fibroid tissue, which contracts and in the lung may produce one of the forms of fibroid phthisis; in the liver, a condition analogous to cirrhosis. The two organs in the body which are most frequently the seat of tertiary syphilis are the liver and the testicle. In the former of these, when it occurs as the localised gumma, the inflammatory material does not usually break down, but under treatment it may be absorbed, producing a puckered cicatrix.

Tertiary syphilitic disease of the nervous system.—Tertiary syphilitic disease of the nervous system is identical in its pathology with tertiary syphilis in other parts of the body, and may affect the Brain, the Spinal Cord, or the Nerves. We may have a diffuse chronic inflammation, leading to the formation of a fibroid material and an induration of the neuroglia or connective tissue; or we may have a localised gumma, generally affecting the meninges or the sheaths of the nerves; or we may have changes in the intima of the arteries leading to their narrowing or occlusion.

In the **skull,** (1) gummata may form on the surface of the meninges, pressing on the cerebral cortex below; or (2) thickening of the membranes may take place from a chronic meningitis, often accompanied by the deposit of lymph beneath the arachnoid; or (3) neuritis may be set up, especially implicating the nerves in the cavernous sinus; in other cases the functions of the nerves which lie in the sinus may be impaired by pressure on them from thickening of the walls of the sinus; or, finally, (4) disease in the central vessels may lead to narrowing and thrombosis or aneurism. Tertiary syphilitic disease of the brain shows itself clinically for the most part as paralysis or epilepsy. In the former the paralysis is generally one-sided and may be partial or complete.

In the **spinal canal** the disease may show itself either as a disseminated sclerosis, which when it affects the posterior columns is believed to be a frequent cause of locomotor ataxy; or it may occur as a chronic meningitis or as a gumma in the membranes. In these latter cases there may be paralysis of a limb, or part of a limb, or complete paraplegia.

In the **nerves**, tertiary syphilitic affections are not common, but minute gummata may occasionally be found in their sheaths.

Treatment of tertiary syphilis.—In the treatment of tertiary syphilis our main reliance must be placed on iodide of potassium. Under its influence tertiary ulcerations will heal and gummatous tumours disappear, often with amazing rapidity. But there are cases constantly met with in which the iodide does not appear to exert its usual influence, and these are, I believe, generally cases in which the patient has not been subjected to any or, if any, to an insufficient course of mercury during the second stage, and these are the cases which in my opinion require mercury in combination with the iodide of potassium during the tertiary stage. There is a good deal of difference of opinion as to value of mercury in the tertiary stage. Some recommend its habitual administration; others recommend that it should be given alternately with the iodide, and others discard its use altogether. I believe that it is indicated in those cases, and for the most part in those cases only, in which an insufficient course has been given during the secondary stage. The iodide of potassium should be given in increasing doses; beginning with a 5-grain dose, it should be gradually increased until the effects produced by it are marked. It is very depressing, and should therefore always be given in combination with ammonia and some tonic, decoction of bark or iron—the ammonia-citrate or potassio-tartrate. Occasionally it produces certain toxic effects from the iodine it contains, coryza, lachrymation, a pustular eruption and marked depression. Sometimes this may be overcome by giving the dose in a largely diluted form, and sometimes, strangely enough, an increase in the dose will cause a diminution in these symptoms. In addition to the treatment by iodide of potassium, the general health of the patient must be carefully attended to. Individuals suffering from tertiary syphilis are always more or less debilitated and very often anæmic, so that attention must be paid to their hygienic and dietetic surroundings. Plenty of fresh air, and above all sea air, is indicated, but at the same time they must avoid all risk of catching cold. Their diet should be carefully regulated, and they should be temperate in all things, but especially with regard to stimulants, and if the mucous membrane of the mouth is affected, with regard to smoking.

INHERITED SYPHILIS

Syphilis may be inherited through the father at the time of conception, or through the mother, or both. The infection through the mother may take place up to a late period of utero-gestation, so that a child may be born apparently healthy and may develop secondaries a month or two afterwards. In addition to this a child may be infected during parturition by a sore on the vulva of the mother, but these are not true cases of inherited syphilis and must be regarded as examples of the acquired form of the disease. If the mother is syphilitic there is a great tendency to abortion or premature delivery, and many consecutive miscarriages may occur, but the condition gradually dies out. When there is a history of a woman after marriage having two, three, or four miscarriages, each occurring at a later period of utero-gestation than the former one; then giving birth to a dead child, and finally to a living one which presents evidences of congenital syphilis, we have a very characteristic condition of things. This tendency to abortion is believed to be most frequently due to syphilitic disease of the placenta, but it may also be due to the action of the syphilitic virus on the infant itself.

With regard to infection by the father, it is of great importance to have some data to know how long after the primary affection he remains capable of communicating the disease to his offspring. But up to the present time we are ignorant of the nature of the constitutional condition which is necessary for the transmission of the disease, and can only be guided by a rough rule formulated by experience. It is generally said that if a man has had a well-regulated and sufficient course of mercury, extending over a period of eighteen months or two years, and has had no evidence of any syphilitic affection for two years after the completion of his course, it is generally safe for him to marry. In connection with infection by the father, it should be noted that the mother, even though she has presented no syphilitic symptoms, cannot be infected by her own infant by suckling it or by being in other ways inoculated by it, whilst a wet-nurse who suckled the same child would almost certainly be infected by it. This is known as *Colles' law*. It may be explained by supposing that the bacillus of syphilis—if there is one, and of this there can be no reasonable doubt—produces a toxine, which is absorbed by the mother in small slowly increasing doses during the period of utero-gestation, until she becomes immune, so that she is really infected though she has never presented any syphilitic symptoms.

Symptoms.—As we have already stated, a child the subject of inherited syphilis may be born apparently healthy and fat when he has been infected late in the period of gestation, but usually syphilitic children when born are small, emaciated, wan and shrivelled, having an appearance something between an old man and a monkey. The skin of the face is loose, wrinkled, and flabby, and the complexion earthy. If the child is born fat he soon begins to waste and emaciate, and assumes this condition. The time at which the symptoms appear varies within certain limits. They are rarely delayed beyond three months, and the most usual time for them to manifest themselves is from four to six weeks after birth. The parts in which congenital syphilis first shows itself are the skin and the mucous membranes; then in the bones and the viscera.

The skin.—Very often the earliest symptom is a roseolar rash, which is often very transient and escapes notice. Following this is a papular eruption, which occurs principally at the angles of the mouth, around the anus, on the scrotum, and in the folds of the groin where the skin is moist and where it therefore assumes the appearance of condylomata (see p. 186). In other parts it assumes the appearance of a lichenoid eruption. Occasionally, as in the acquired form, the epithelium over the papules desquamates so as to give them a squamous appearance like psoriasis. This is frequently seen on the soles of the feet.

Another form of eruption in congenital syphilis is a diffuse erythema, and as this generally occurs about the nates it is very liable to be mistaken for erythema intertrigo caused in the same situation by the irritation of urine. Finally a bullous eruption, the so-called *pemphigus*, is not an uncommon eruption in cases of inherited syphilis. It is always a serious sign, as it indicates grave constitutional depression.

The **mucous membranes.**—The mucous membrane of the nose and mouth is constantly affected in congenital syphilis. In fact, a congestive swelling of the mucous membrane of the nose is one of the earliest and most characteristic signs of the disease, and the peculiar snuffling noise in breathing which it causes has given the popular name to the disease as a whole, 'The snuffles.' The breathing in this condition is obstructed sometimes to such an extent that the infant is unable to suck, as it can only breathe when the mouth is open. The mucous membrane of the mouth may be affected with a stomatitis, a general, diffused inflammation of the mucous membrane, which is popularly known by the name of 'thrush ;' or mucous patches may appear on it, similar to the condylomata on the moist skin, and like them exceedingly infective.

The **bones.**—The bones are frequently and variously affected in congenital syphilis. Some of these changes consist in atrophy of the pre-existing structures; others in development of new tissue. The condition of atrophy shows itself principally as *cranio-tabes*, which is not, however, necessarily a syphilitic affection, but may occur also in other diseases, as rickets. It consists of a thinning of the bones of the skull in patches. The condition generally occurs in those parts where the head is subjected to pressure, as the occipital and less frequently the parietal region. The bone may become so thinned that it feels like parchment under the finger, or the osseous tissue may be entirely removed, leaving only a layer of membrane. The hypertrophic condition consists in the deposit of new bone on the outer surface of the skull, at points most remote from the centre of ossification. It most frequently occurs at the anterior fontanelle in the two parietal bones and the two segments of the frontal bone ; here new bosses of bone may be heaped up to such an extent as to give the skull in this situation the appearance of a 'hot cross bun ;' the lines of the sutures representing the cross. The same thickening also occurs along the line of the sagittal suture. Another condition of the bones met with in congenital syphilis is the so-called *syphilitic epiphysitis*. It is really a disease of the ossifying tissue at the end of the shaft, named by Parrot the chondro-calcareous layer. This becomes thickened and infiltrated with small round cells, which destroy and replace the natural tissue of the part and cause separation of the epiphysis from the shaft. There is thickening and tenderness about the joint, and the limb hangs powerless, being in a condition which Parrot termed pseudo-paralysis. The looseness of the epiphysis can generally be detected, and some fine crepitus is usually present.

The **viscera** in congenital syphilis are liable to become involved, a diffuse infiltration of small round cells taking place in them, causing enlargement of the organs. In syphilitic children born dead, or in those who die shortly after birth, the spleen, the liver, and in some cases the lungs, may be found to be extensively diseased.

Manifestations of inherited syphilis in later life.—The principal manifestations of congenital syphilis in later life are to be found in the condition of the teeth, the eyes, the nose, and the bones, but in addition to these there are some others of perhaps less frequent occurrence, which will have to be alluded to after the principal ones have been described.

The condition of the **teeth** in hereditary syphilis depends upon the stomatitis, and therefore, if this affection has been absent during the early period of the disease, the characteristic condition of the teeth is also absent.

Stomatitis causes defects in both the temporary and permanent teeth, but it is the latter with which we are more especially concerned, as it is in them that we find the condition which, when present, is so characteristic of inherited syphilis. Stomatitis causes injury to the enamel organ of the developing temporary teeth, and causes them to decay as soon almost as they appear through the gums. The permanent teeth, however, present the most characteristic appearance, and this is also due to the stomatitis, and therefore the condition shows itself chiefly in those teeth which are erupted first and are therefore nearest the surface during the stomatitis. The central incisors of the upper jaw are the ones in which the condition is best marked. These teeth are dwarfed, and their cutting edge is marked by a semilunar notch (fig. 41). In some cases the cutting edges are narrowed.

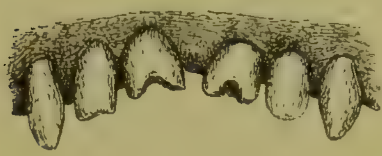
FIG. 41.—Teeth in hereditary syphilis. (After Hutchinson.)

The characteristic lesion of hereditary syphilis in the **eye** is a condition to which the name of *interstitial keratitis* is given. It usually shows itself between the ages of six and fifteen, but it has been known to occur as early as two and as late as eighteen. It consists in an infiltration of the substance of the cornea with cells, which give to it a hazy appearance like ground glass. It commences in the centre of the cornea and spreads to the periphery, and is accompanied by the formation of new vessels between the lamellæ. Sometimes these new vessels are very numerous and give to the cornea a salmon colour, which is known as 'salmon patch.'

In many cases of inherited syphilis the **nasal bones** do not develop to their full extent; this gives to the individual the unsightly appearance of a depressed bridge of the nose. This condition is due to the rhinitis which, as we have seen, is one of the earliest and commonest conditions of congenital syphilis. The inflammation of the mucous membrane of the nose extends to the periosteum, which becomes so altered in structure, that it is unable to complete the formation of the nasal bones.

The most common condition met with in the **bones** in the later stages of hereditary syphilis is a general condition of ostitis, which usually commences about the same time as the interstitial keratitis. The disease more frequently implicates the tibia than any other bone, but the fibula and the bones of the forearm are sometimes the seat of the disease. The whole of the bone becomes involved, and is not only increased in girth, but also in length. The disease goes on to sclerosis, and the whole of the shaft is converted into a dense, hard mass of sclerosed bone, with obliteration of the medullary canal. Occasionally nodes are formed as a late condition of inherited syphilis. There is another condition affecting the bones of the hand, to which allusion must be made, which may occur either in congenital or acquired syphilis. It is called *syphilitic dactylitis*, and is of interest principally from a very similar condition occurring in children as a result of the tuberculous state and known therefore as tuberculous dactylitis. The disease is a gummatous periostitis frequently ending in necrosis. The bone involved becomes enlarged, and the symptoms much resemble the tuberculous form of the disease, but the two conditions should be distinguished from each other.

Among the rarer conditions of congenital syphilis may be mentioned :

(1) gummatous ulceration, most frequently attacking the skin of the face and the legs; (2) symmetrical synovitis, principally involving the knee-joints and being attended with an effusion into the synovial sac, which is exceedingly intractable, but rarely implicates the other structures of the joint; (3) affections of the internal ear, leading to deafness, the exact nature of which is not known; (4) chronic enlargement of the lymphatic glands of the neck and other parts; and (5) gummata of the liver, spleen, brain, testicle, or other organs. It should be mentioned in addition that frequently fissures may be observed radiating from the angle of the mouth as a result of stomatitis and mucous patches in this situation. When present they afford an indication of the syphilitic nature of the case, but they are not characteristic, as they may also be caused by eczema.

Treatment.—There is only one remedy for congenital syphilis, and that is mercury; but care and discrimination are required in its administration, and care also is required in feeding the child. To take the last point first, the child should be always nursed by the mother, if she is in good health and has sufficient milk; but this is often not the case, the mother herself being frequently syphilitic and unable to supply sufficient nourishment for her child. Under these circumstances the child must be brought up by hand and must on no account be suckled by a wet-nurse for fear of infecting her. The greatest care must be taken in the artificial feeding, and one of the various plans for approximating the quality of cow's milk to that of human milk adopted.

There are two ways of administering mercury—by the mouth, or by inunction, and after a very considerable experience of both plans I have come to the conclusion that the latter is the better of the two, if only it can be efficiently and thoroughly carried out. It is less likely to interfere with the child's general health, or to produce diarrhœa, which cannot in a young infant be combated by small doses of opium, as it can be in the adult. The plan I adopt is that originally recommended by Sir Benjamin Brodie, except that instead of using the blue ointment, I use the oleate of mercury as being less irritating and more easily absorbed. A drachm of the oleate of mercury (10 per cent.) is spread on a flannel bandage and fastened round the child's belly. Each day after a hot bath a fresh quantity of ointment is applied. Under this treatment the child rapidly improves; the eruption, snuffles, and other symptoms disappear, and the child fattens and assumes a more healthy appearance. When the mercury is given by the mouth, grey powder is the best form to give it in; a grain two or three times a day may be given with safety even to young infants as they bear mercury very well. In a considerable number of cases, however, it produces purging, with green stools, and the treatment by inunction will have to be resorted to. In extreme cases of syphilitic marasmus, cod liver oil will be found to be a useful adjunct to the mercury. The mercury should be continued for some time, three to six months, after all symptoms of inherited syphilis have disappeared, and there need be no fear of its doing the child harm; in fact, it seems to flourish under the administration of the drug.

In the treatment of congenital syphilis in children of riper years, iodide of potassium in combination with iodide of iron will be found the best means of combating the disease, and if mercury is given it should be in very small doses over a very long continued period of time.

CHAPTER V

TUBERCULOSIS

Tuberculosis is an infective disease due to the action of a specific micro-organism—the tubercle bacillus—which results in the formation of minute structures called 'tubercle.' This material may remain local, spreading and infecting the tissues locally, or it may become disseminated, producing widespread tuberculous deposits in the various tissues and organs. The former of these two conditions, *local tuberculosis*, is the form of disease which the surgeon has more especially to deal with, but he should also be fully alive to the constitutional condition, *general tuberculosis*, since frequently, cases of the local form, which he may be called upon to treat, terminate in this general infection.

It will be convenient first to consider tubercle; its structure, and the changes it undergoes.

Tubercle.—The term 'tubercle' has been variously applied. Formerly it was the name given to certain cheesy masses, which are now known to be secondary states of the original condition, produced by fatty degeneration. Then it was applied to certain greyish white semitranslucent bodies, of about the size of a millet seed, which were also sometimes called 'grey granulations' or 'miliary tubercles.' Subsequently by microscopic examination it was found that these grey miliary tubercles were made up of an aggregation of smaller nodules, too small to be seen by the naked eye, but possessed of a certain definite structure. To these bodies the term tubercle is now, in its strictest sense, only applied. The miliary tubercle or grey granulation, made up of a collection of tubercles, is a greyish white, translucent body, with a well-defined outline, generally surrounded by a zone of hyperæmia, of firm consistence, and usually about the size of a millet seed. It is non-vascular, and is a characteristic feature of the disease. Sometimes these grey granulations are aggregated together into larger masses, and then, though the granulations are themselves non-vascular, vessels may be seen between them, running in the remains of the normal tissue of the part, which lies between the individual circumscribed deposits.

In examining these miliary masses, it will be found that they are generally arranged along the course of the smaller blood-vessels with which they are closely connected. In fact, it is believed by some that the deposit first takes place in the outer coat of these blood-vessels.

Microscopic characters of tubercle.—When examined under the microscope, an individual tubercle in its complete condition is seen to be made up as follows: In the centre is a large giant cell, that is, a large multinucleated cell, with well-marked branching processes; around this, between the branching processes of the giant cell, is a zone of 'epithelioid cells;' cells which resemble young squamous epithelium, and outside this is a zone of small round cells, between which is a fine reticulum, probably derived from the branching processes of the giant cell (fig. 42). The giant cells are granular masses, often containing vacuoles, in which there are many nuclei, which have a somewhat characteristic arrangement. They are usually to be found arranged in a horse-shoe shape at one or more parts of the border of the giant cell. Their nuclei are large, clearly defined, and of an oval form. The giant cell is not essential to a tubercle, for many are found in which it is not present, and their exact origin is uncertain. By some they are believed to be merely coagulated lymph inclosing cells; by others they are believed to be masses formed by the coalescence of epithelioid cells; and again, others believe that they are caused by the fusion of leucocytes around a bacillus.

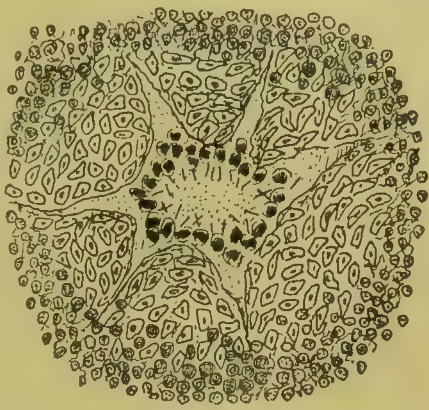

FIG. 42.—Tuberculous nodule. Diagrammatic.

The epithelioid cell is the most characteristic element of the tubercle. It consists of granular protoplasm, with a single clearly defined oval nucleus, exactly the same as the nuclei of the giant cells, which is a reason for believing that the giant cell is produced by a coalescence of the epithelioid cells. The cells are derived from the connective tissue cells of the part, which undergo proliferation. The round cells forming the outer zone of the tubercle are merely emigrated leucocytes. The tubercle is formed in the following way: when a tubercle bacillus is lodged in a part, it sets up an irritation which causes a proliferation of the connective tissue cells of the part, especially the endothelium of the small blood-vessels and lymphatics, and in this way the epithelioid cells of the tubercle are formed. At the same time the leucocytes migrate from the adjacent vessels and collect around the epithelioid cells, forming the outer zone of round cells of the tubercle. Subsequently the giant cell is formed, probably either by lymph coagulating and inclosing some of the epithelioid cells in its meshes, or by a fusion of the epithelioid cells into one large mass. Within the tubercle no blood-vessels are to be seen, but around it is often a zone of vascular congestion.

The *bacillus* is principally found in the giant cells, but also to a certain extent in and around the epithelioid cells (fig .43). It is a rod-shaped organism, about one-third to two-thirds the diameter of a red blood corpuscle in length, and five times as long as it is broad. It has usually a beaded appearance, but is sometimes homogeneous. It is non-motile, but may be transmitted from one part to another by being taken up by wandering cells, which enter the lymph stream. Tubercle may also be disseminated by the entrance into the blood stream of softened tuberculous matter, which gives rise to tuberculous formations in other parts of the body. But in all probability the bacilli do not infect the blood and multiply in it. The bacilli may effect an entrance into the body in several different ways. They may find an entrance through the respiratory mucous membrane, being inhaled with the air, or through the gastro-intestinal mucous membrane, being swallowed with the food, as in the milk of tuberculous cows; or they may be introduced through any wound or breach of surface of the body.

The fate of the tubercle.—Before tubercle has reached any considerable size or has existed for any length of time, it begins to undergo a degenerative change; that is to say, fatty degeneration or *caseation.* This process begins in the centre of the nodule, at the part farthest removed from the source of nutrition. The nodule becomes opaque, yellowish white, and friable, and forms a cheesy-looking mass, which is circumscribed, homogeneous, and firm. It is now to be regarded as a piece of dead tissue or a slough, which has to be got rid of or rendered inert. The further changes which it undergoes are in one or other of these directions. It may act in the same way as a piece of dead tissue; it may cause irritation in the tissues around and set up suppuration and be cast off as a slough. Generally, however, at the same time that suppuration is going on in the tissues around, a liquefaction of the caseated material takes place, and it becomes converted into a creamy or curdy material. This is sometimes called pus, but it is not so; it is merely a curdy fluid consisting of the débris of the caseated material and water, any pus cells which it may contain being derived from the suppuration in the tissues around.

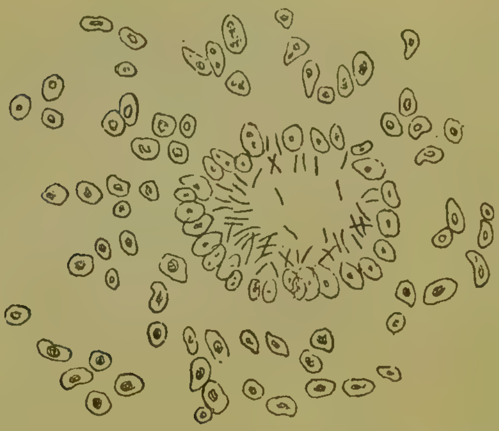
FIG. 43.—The tubercle bacillus in the giant cell of a tuberculous nodule. Diagrammatic.

A caseous mass of tubercle may be rendered inert by becoming encapsuled. A sort of fibrous envelope is formed as the result of inflammatory changes in the normal tissues around, and the cheesy matter becomes inclosed and shut off from the rest of the body. Caseous tubercle may also to a great extent be rendered inert by undergoing a process of calcification; it dries up, becomes firm and hard and infiltrated with lime salts, so as to form a chalky mass. But it must be borne in mind that this cretaceous mass may at any time be awakened to renewed activity, and suppuration may take place around it.

When tubercle liquefies it forms what is called a *tuberculous abscess.* This is the cold abscess, which has already been described (p. 116).

The causes.—The immediate cause of tuberculosis is the presence of the tubercle bacillus, but for it to become operative something more than its presence is necessary; we must have in addition a suitable soil in which the micro-organism can grow and flourish. We shall have, therefore, to consider first the causes which favour the entrance into the body of the bacillus, the *seed*; secondly, the causes which render the tissues favourable for its reception, the *soil.*

The seed.—As we have already seen, the tubercle bacillus can be introduced into the body through a wound, or by the mucous surfaces of the respiratory and digestive tracts. That the tubercle bacillus can be transmitted by inoculation has been abundantly proved both by experiments on animals and also by clinical experience. If cultivated bacilli or some product of tuberculous disease is inoculated into an animal, it produces a tuberculous condition at the seat of inoculation, and from this a general tuberculosis may be set up. As might be expected when tuberculous products are used for the purposes of inoculation, the effects produced vary with the material used. For example, the tissue of a grey granulation will produce much more rapid tuberculosis than material from a caseating mass. This is probably due to the fact that as caseation advances the bacillus breaks up and perishes; but nevertheless caseating tubercle is distinctly infective; this is probably due to the fact that though the bacillus is destroyed its spores remain and are capable of exerting their virulent properties. There is a certain amount of clinical experience helping to prove that tubercle can be transmitted by inoculation. Scattered up and down the pages of medical literature are cases where the direct communication of the disease by inoculation is incontestably proved; cases, for example, where the tubercle has been inoculated during the rite of circumcision. The surgeon occasionally has an opportunity of seeing this after such an operation as excision of the hip for tuberculous disease. The operation is performed, and the curdy contents of the tuberculous cavity necessarily during its evacuation runs over the cut edges of the wound in the skin. After the operation the deeper parts of the wound may heal and the case do well, but an unhealthy tuberculous ulceration of the skin about the edges of the wound sets in and requires a vigorous scraping before it can be got to heal. This is no doubt due to the inoculation of the edges of the wound by the tuberculous material. Transmission of tubercle by respiration has also been proved by experiments on the lower animals. By shutting up healthy animals with tuberculous ones tuberculosis can after a time be induced, especially if the animals are confined in a limited space, without free ventilation. Cases have also been recorded where the transmission of tubercle from one person to another through the respiratory organs has at all events seemed probable. But it is possible that in these cases absence of free ventilation is an important factor in the production of the disease; as, for instance, in a case where the husband contracted the disease from his wife during a long voyage in which they occupied the same cabin. A very marked example of this form of transmission came under my notice some years ago. A baby a few months old and a boy of about three were placed to sleep in the same room with a nurse who was in an advanced stage of tuberculous disease of the lungs. The baby died of tuberculous meningitis, and the boy developed tuberculous disease of the hip joint. The father and mother and two older children are perfectly free from any tuberculous taint, and as far as can be ascertained there has never been any tuberculous disease in any member of the family. Transmission of tubercle through the food is not uncommon. The most probable way in which it is transmitted is by milk from tuberculous cows. The risk of transmission by meat which has been cooked is probably small. That tubercle can be transmitted through the alimentary canal has been proved by mixing tuberculous tissue with the animal's food. This has set up ulceration of the intestine, and enlargement of the mesenteric glands and general dissemination.

The soil.—This is probably of as great importance as the seed, for unless there is a suitable condition of the tissues for the growth of the bacillus, it perishes or disappears, and no evil effects result from its introduction into the body. It is probable that everyone frequently takes into his body tubercle bacilli, but they do not develop because the general or local conditions favourable for their growth are not present. There are, however, certain individuals, who for purposes of distinction may be termed tuberculous individuals, whose tissues form a suitable soil for the development of the micro-organism; if such an one admits into his body the bacillus, it will develop and multiply, and tuberculosis will be the result. This condition of tissue may be inherited or may be acquired. The tuberculous parent begets children who have tissues in which the tubercle bacillus can flourish—in other words, who have a predisposition to tuberculosis—but the tuberculosis will not declare itself unless the microbe is admitted into the body. Again, a child may be born of perfectly healthy parents, or at all events of parents free from any tuberculous taint, but he may be exposed to unhealthy hygienic surroundings, bad food, insufficient air, and so on, and he may acquire a predisposition to the disease, that is, a condition of tissue favourable to the growth of the micro-organism, and if now the bacillus is admitted, tuberculosis is the result.

In speaking of the predisposing causes of tuberculosis, it is necessary to allude to the *local* predisposing causes, which at all events are of importance in locating the disease. An individual with a constitutional predisposition to tuberculosis *may* not develop any signs of the disease, even supposing that the tubercle bacillus gains an entrance into his body, if these bacilli are not admitted in any great number and the resisting powers of his tissues are not very greatly deteriorated; but if this individual gets any slight injury or inflammation which locally deteriorates some tissue or tissues, we get a condition of things at this particular part which still further favours the growth of the bacillus, and a local tuberculous affection is set up. It is a matter of every-day experience to find that a tuberculous synovitis is attributed to a strain; or a case of caries of the spine to a blow or injury of the back; or a tuberculous gland in the neck to a slight inflammatory condition set up by a carious tooth, or a patch of eczema on the scalp or to some such slight irritation. The injuries are usually trivial, and in the perfectly healthy individual would lead to no evil result, but in the constitution predisposed to tuberculosis they set up serious mischief if any tubercle bacilli are admitted to the locally deteriorated tissues.

Pathology.—The *tuberculous process* is inflammatory in its nature, but is unattended by many of the signs which we are wont to recognise as the signs of inflammation; it is essentially chronic, of a slow and insidious character, and of a low type. It is attended by an exudation of a material which, unlike the exudation of an acute traumatic inflammation—granulation tissue—is ill formed and unstable, and shows no tendency either to develop into scar tissue or degenerate into pus. It slowly undergoes a process of caseation, which must be looked upon as the most characteristic feature in the tuberculous process. Having undergone this process it becomes a mass of dead tissue, which must be got rid of: this it does in the manner described above; it undergoes liquefaction, which is a purely physical and chemical change; suppuration may take place in the living tissues around, with the object of getting rid of the necrosed material, and the curdy débris of the cheesy mass together with the pus is discharged from the surface of the body and is thus got rid of. Then comes on the process of repair of the cavity which is left, and this is always slow and uncertain, and the scar tissue which is formed is feeble, unhealthy, and liable to give way and break down.

Take, for example, as an illustration of the process, a tuberculous gland in the neck. A child, from some trifling cause, such as the irritation about a decaying tooth or some local trouble about the throat or tonsil, gets an inflammatory enlargement of a neighbouring lymphatic gland. And here it may be noted that in these tuberculous cases the amount of local irritation may be very trifling and very slight in proportion to the amount of mischief it sets up. The enlarged gland is not tuberculous in the first instance, but the inflammation in it converts it into a favourable site for the encroachment of the tubercle bacillus, which may find an entrance through the lesion which has caused the enlargement. After a time grey granulations become dotted about in the gland tissue, and soon small caseous points appear, which increase in size and coalesce till the whole gland becomes a uniform caseous mass, inclosed in a thickened capsule. The process may terminate here, and the cheesy mass may become calcareous or encapsuled and remain inert. But what generally happens is that it softens and liquefies, while inflammation and suppuration take place in the tissues around, the capsule gives way, and the material gradually finds its way to the surface, and undermining the skin to a considerable extent eventually perforates it and the curdy fluid is discharged. The sinus resulting usually remains open for a considerable time, and the process extends locally, by affecting adjacent tissues, so that on opening up one of these cavities formed by the discharge of caseated material, sinuses may be found burrowing in all directions. When cicatrisation takes place, the resulting scar is usually of a dusky hue, consisting of thin flimsy material, and great deformity is produced from puckering of the neighbouring skin. From this it will be seen that tuberculosis is a purely local condition in the first instance, and that it has a great tendency to extend locally, by infecting adjacent tissues; but in addition to this the tuberculous virus from this infecting centre may be carried to all parts of the body and a condition of general tuberculosis may be set up.

Symptoms.—The tuberculous individual presents, in many instances, certain characteristics by which the condition may be recognised, and these present themselves as two distinct and separate types. They are specially to be recognised in children and young adults.

1. **The fair or sanguine type.**—Children belonging to this type have soft, transparent, thin skins, so that the cutaneous vessels show through. The hair is light-coloured, fine and silky. The eyelashes are long. The eyes are bright, with blue irides and large pupils. The sclerotic has a bluish tinge, from its thinness allowing the choroid to show through. The face is oval and the lower jaw small, and the whole expression pleasing and sometimes beautiful. The mental powers are considerable and early developed. This form of tuberculosis is usually inherited.

2. **The dark or phlegmatic type.**—Individuals of this type are short, stunted, and bulky. The expression is sullen and forbidding. The skin is harsh, swarthy, and thick. The hair is dark, thick, curly, and often very abundant. The lips are thick and tumid. The teeth ill formed, and soon become carious. The mental capacity is slight, and there is a torpor or languor about all their movements. Their circulation is slow, and the cheeks often present in consequence a dusky red hue. They are very liable to suffer from chilblains. This form is usually acquired and is sometimes known as 'workhouse' tuberculosis, as it is largely met with in the inmates of these places.

The **local signs** of tuberculous disease differ with the part or organ affected; they will, therefore, be considered with the other diseases of the various tissues or organs.

The **constitutional symptoms.**—In the majority of cases of tuberculous disease, especially when it occurs in external parts, there are no recognisable symptoms of constitutional disturbance: the patient makes no complaint of feeling ill, and presents no indications that he is otherwise than in the enjoyment of his ordinary condition of health. In some cases, however, and this especially applies to tuberculous disease in joints, there are frequently evidences of slight febrile disturbance. There is usually some slight elevation of the temperature at night, and this is especially the case after caseation has commenced. In fact, one of the best indications, in a case of a tuberculous joint, that caseation has commenced, and that therefore the probabilities of obtaining a cure by long-continued rest are not favourable, is the occurrence of a slight rise in the temperature every night, and this is often an important factor in determining the treatment. When general tuberculosis supervenes on a local tuberculous trouble, the first indication is generally a considerable nightly rise in the temperature: though in some cases the rise may be in the morning. But, at all events, if in the course of any local tuberculous condition the temperature suddenly mounts up to 103° or 104° F. without any local condition in the part to account for it, the very gravest apprehensions should be entertained that some acute condition, as tuberculous meningitis or acute pulmonary trouble, will assert itself ere long. And this is especially the case in children.

Scrofula.—Scrofula is a term which has never been very clearly defined, and up to quite recent times has been used rather to express the idea of a diathesis than a disease. It was said to mean a constitutional disease, which predisposed those who suffered from it to the occurrence of a low form of inflammation of a peculiar type. We now know that this low form of inflammation is nothing more or less than a tuberculous condition, and that a so-called scrofulous gland which has broken down is pathologically and etiologically identical with a tuberculous vomica in the lung; so that the time has arrived when the term 'scrofula,' or its synonym 'struma,' should be banished from medical literature. As Mr. Treves says, 'There is no disease requiring the special designation, scrofula. The term was a convenient one to cover ignorance. It has served its purpose and may now be most profitably abandoned.'

Treatment.—In dealing with the treatment of tuberculosis, we must consider first the *preventive* treatment, by which we mean an endeavour to prevent any manifestation of the disease in those who present any predisposition to it, either from hereditary or acquired causes. An individual may be what we have termed a tuberculous individual and still may never present any manifestation of tuberculous disease, and our endeavours should be, by preventive treatment, to prevent these manifestations in these cases. And this to a very great extent may be done by strict and continuous attention to hygienic and dietetic rules; by, in fact, keeping the patient in the best possible condition of health, which will, in spite of his predisposition, enable him to overcome any inroads of the tubercle bacillus, provided they are not admitted in any considerable numbers. Attention should be paid, therefore, to all the patient's surroundings. He should have plenty of fresh air, live in well-ventilated rooms both by day and by night, and be out in the open air as much as possible. He should, if it can be done, reside in a dry and equable climate, and especially at the seaside. He should be warmly clad and always wear woollen garments next his skin, and by baths and friction promote its action. His diet should consist of light, nutritious, unstimulating food, and care should be taken never to overload the stomach, and if necessary, by occasional aperients, keep the bowels freely acting. He should be allowed moderate exercise, not carried to the point of fatigue. In one word, by careful and temperate living he should endeavour to promote a healthy condition of body.

As regards the *curative* treatment after the local condition of tuberculosis has been set up in some part there are four indications: (1) to remove the cause; (2) to keep the part at rest; (3) to remove, if possible, the caseating focus; and (4) to treat the constitutional condition.

(1) The first point in the treatment of these cases is to remove the cause, when this can be ascertained. As we have seen, many cases of tuberculous disease, especially when it occurs in the lymphatic glands, are caused by some slight irritation, which first of all produces a lymphadenitis, and this subsequently becomes tuberculous. In these cases the local source of irritation should be got rid of or treated with a view to this end; a carious tooth or an enlarged tonsil should be removed; any eruption about the skin should be treated, and so on. But in many cases the irritant which produced the primary inflammation has been temporary; a blow or a strain producing caries of the spine or tuberculous disease of a joint, and then, of course, nothing can be done.

(2) A most essential point in the treatment of all tuberculous inflammations is perfect rest, both mechanical and physiological. No one who has had any opportunities of watching the effect of rest in cases of tuberculous disease of joints or the spine can doubt its efficacy. But this rest to be of any use must be absolute and complete, and must be continued for a long period. It is not sufficient, in a tuberculous knee-joint for instance, to keep the patient in bed and prevent him putting his foot to the ground. The joint must be fixed so that no movement can take place in it; nay, more than this, means must be taken, by extension or otherwise, to prevent the articular surfaces from pressing against each other, as they are liable to do from the reflex spasm of the muscles which is set up, and so by keeping up a continual condition of unrest inevitably prolong the disease and prevent recovery. And what applies to tuberculous disease of joints applies to all other forms of tuberculous disease: if the part can be kept absolutely at rest, the tendency is to recovery; if, on the other hand, a condition of unrest is maintained, the chances of recovery are far more remote.

(3) When the tuberculous disease has reached the caseating stage it is often right and proper to remove it, if it is in an external part and can be removed without undue risk to the patient. A great deal of care and discrimination is required in these cases in arriving at a determination as to the propriety of operation, especially when the operation involves the removal of important organs, such as a joint or the testicle. The cases in which the question of the removal of a tuberculous focus has to be considered are most frequently when the disease affects the lymphatic glands. In these the operation should never be undertaken until there is evidence of distinct softening of the caseated material, but when this is so the sooner the gland is removed the better. Until softening occurs the condition is recoverable from, or, at all events, the diseased gland may become encapsuled and inert, but after liquefaction has commenced there is no probability of this taking place. When the removal of the tuberculous condition involves the removal of some important part, as a joint or the testicle, the operation should never be performed until spontaneous recovery is hopeless, or at all events very uncertain and remote. When removal is resorted to, care

should be taken to remove as far as possible every particle of the disease, and if the surgeon does not feel confident that he has succeeded in doing this the part should be freely swabbed out with some caustic, of which probably a solution of chloride of zinc (gr. xl ad ℥j) is the best.

(4) The constitutional treatment of tuberculosis consists in following out the rules which were laid down for the preventive treatment of the disease, and giving such drugs as will improve the patient's general health, for there are no drugs which are specifics against tubercle. Still there can be no question of the great advantage of the judicious administration of cod liver oil, especially during the cold weather of winter; iron also is useful in those cases where there is anæmia, and is most frequently and beneficially employed when combined with iodine, in the form of the iodide of iron. In addition to these remedies an occasional purgative may be required to keep the bowels open.

Senile tuberculosis.—Tuberculosis is essentially a disease of early life, but middle-aged and even elderly people are sometimes attacked by it. In most of these cases there is the history of tuberculous trouble in early life, from which the patient has recovered; in others there is an hereditary taint. The disease is generally apparently excited by some cause which has depressed the patient and produced a deterioration of the vital powers. In its pathology and clinical manifestations it is identical with tuberculosis in the young, and the treatment is the same, but the disease at this age holds out little prospect of cure.

CHAPTER VI

RICKETS

Rickets is a constitutional disease, essentially due to malnutrition, the chief manifestations of which are found in the bones, but which implicates other organs, especially the great viscera. The disease may commence in utero, and many cases of intra-uterine fracture are ascribed to this cause ; but the most usual time for its appearance is between the first and second year, though it may appear later. A form of rickets has been described under the name of 'late rickets,' in which the disease has not appeared until the age of ten to thirteen, but it is probable that these are cases of recurrence where the early attacks have not been noticed. The disease is confined to childhood, and an important characteristic of it is its tendency to disappear, the child entirely recovering from the constitutional condition, though the deformities produced by it remain for life. It rarely causes death directly ; but by impairing the general health it indirectly causes death in many cases from some intercurrent disease.

Etiology.—Rickets is a disease of malnutrition, induced by improper food, and exaggerated by the want of healthy hygienic surroundings. The natural food of an infant for the first nine months of its life is its mother's milk, and rickets is induced by this milk not being of a proper quality or by the substitution for it of some artificial food, which either lacks some constituent of the mother's milk, or else contains some harmful substance. The former of these two is usually believed to be the more potent cause, and Cheadle believes that the material which is deficient is animal fat. Others, however, are of opinion that rickets is rather due to the administration of starchy food, which the infant is unable to digest on account of the deficient action of the pancreas.

There appears to be no connection, as was formerly supposed, between rickets and syphilis, beyond the fact that syphilis naturally induces a condition of debility on the part of the mother which may conduce to the occurrence of rickets in the child from malnutrition arising from deficiency in the supply of nutrition. In the same way tuberculosis and rickets may be indirectly connected, but at the same time there is no direct relationship between the two.

Pathology.—In rickets the pathological changes are principally found in the bones, but also in many cases in some of the viscera.

The changes in the bones are most marked in the neighbourhood of the epiphysial cartilages, where they become enlarged, but changes also take place in the periosteum and the whole bone becomes softer than natural and deficient in its earthy constituents.

The changes in the neighbourhood of the epiphysial cartilage are due to the abnormal excess in the quantity and the imperfection in the quality of the natural process of ossification going on in the ossifying tissue on either side of the epiphysial cartilage. Thus the cartilage cells in the layer of tissue which is about to ossify are greatly increased in number, and between them the vascular medullary spaces are of large size, many of them having undergone premature calcification. The enlarged vascular medullary spaces between the cells show no regular arrangement, as in normal ossification, and often project for a considerable distance into the cartilage which has not yet commenced to ossify. The osteoblasts, which in normal ossification are arranged in a layer on the interior of the medullary spaces, show in these cases no definite arrangement, and are mingled with cartilage cells which have either calcified or remain unaltered. The adjacent bone, that is the bone which has last been formed, is soft and spongy and contains islets of cartilage which have escaped ossification. It is to this greatly increased proliferation of the cartilage cells and this formation of loose spongy bone that the enlargement of the ends of the shafts of the long bones is due (fig. 44). The deeper layer of the periosteum (osteogenetic layer) is much thickened, soft, and vascular, and between it and the bone is a layer of spongy material, in which islands of calcification appear and which is gradually converted into a soft spongioid bone. As the bone increases in girth and the normal osseous tissue which was formed before the disease commenced becomes absorbed in the formation of the medullary canal, it may come to pass that the whole shaft of the bone may consist of this soft spongy material. If the disease is recovered from without the bones undergoing any alteration in shape this condition disappears, the spongy bone becomes converted into exceedingly hard dense bone by an inflammatory process, which consists in the deposition of inflammatory exudation in the loose cancellous tissue, and this becomes converted into scar tissue and then into osseous tissue; so that the bones of a child who has suffered from rickets in its infancy are usually hard, dense, and sclerosed. But if, on the other hand, the bones become bent,

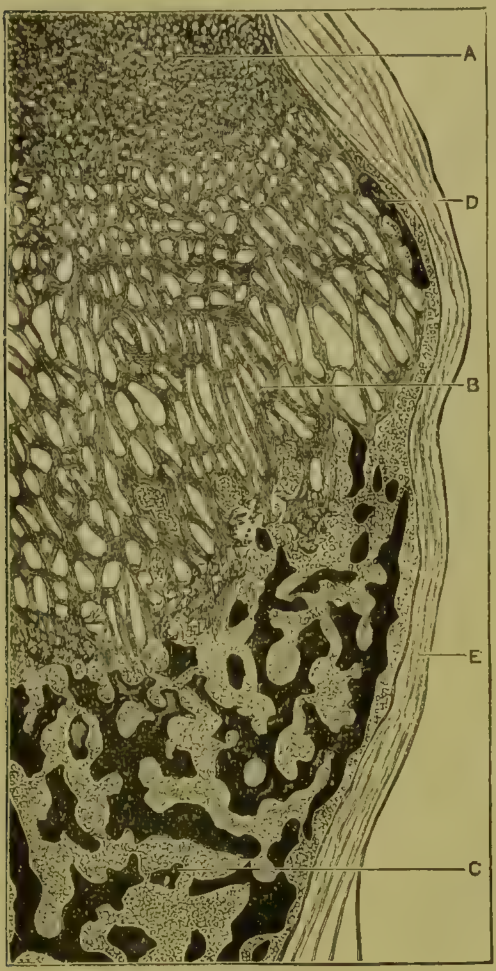

FIG. 44.—Costal node in rickets. The section represents the junction between a costal cartilage and a rib. A, normal costal cartilage; B, proliferating layer; C, imperfectly calcified bone; D, a small spicule of periosteal bone; E, laminated periosteum.

N.B.—In the proliferating layer the matrix only, and not the cartilage cells, is represented. (From Holmes's 'Principles and Practice of Surgery.')

a quantity of this same spongioid material is laid down on the concavity of the curve in order to strengthen it, and this undergoes the same sclerosing process and forms a dense, hard, compact mass of bone, which fills in the concavity and forms those buttresses which are so frequently found in rickety bones (fig. 45). The bending which takes place in soft rickety bones is due partly to pressure exerted by the weight of the trunk in walking or crawling and partly to muscular action. Under normal conditions the action of the muscles produces the slight curves of the healthy bone; but in rickets these curves are exaggerated by the diseased condition of the bones offering an inefficient resistance to the action of the muscles. The curvatures of rickety bones are, therefore, exaggerations of the normal curves.

The liver and spleen are often very considerably enlarged in rickets, but the pathological nature of the enlargement is not very well understood; it is believed by Dickinson to be due to an increase principally of the fibroid elements of these organs, though he says that the glandular tissue is somewhat increased also. The kidneys and the lymphatic glands also often show a similar increase, though to a less extent. As the child grows and gets rid of the disease, these organs resume their natural size, and no trace of the enlargement is left in after life.

It is necessary to describe briefly the changes in the skeleton which are induced by the deformities of the bones caused by rickets, as some of them are of vital importance in connection with the well-being of the individual in after years.

The **Skull** becomes enlarged from the formation of the same soft, spongy bone as was noted as occurring under the periosteum in the long bones. The whole of the vault of the skull may become converted into a thick, crumbly, porous bone, in which all distinction between the compact tissue of the outer and inner tables and the diploe is lost. This imperfect bone is unable to resist pressure, and therefore wherever it is subjected to this force it becomes absorbed. This is most frequently seen in the occiput, where the bone is subjected to pressure on the inside by the brain and on the outside as the child lies in its cot or rests its head on the nurse's arm. The same change also occurs over the parietal eminences. In this way the entire thickness of the bone may be absorbed, and nothing but a membrane left between the scalp and the dura mater at the point of pressure. This condition is termed *cranio-tabes*, and is similar to the condition noted as occurring in hereditary syphilis (p. 197). As the child grows the spongy bone becomes sclerosed, and the enlargement of the head remains throughout life, producing a characteristic deformity: the large head and prominent forehead contrasting with a small face. The fontanelles in rickets are slow in closing, the anterior one sometimes

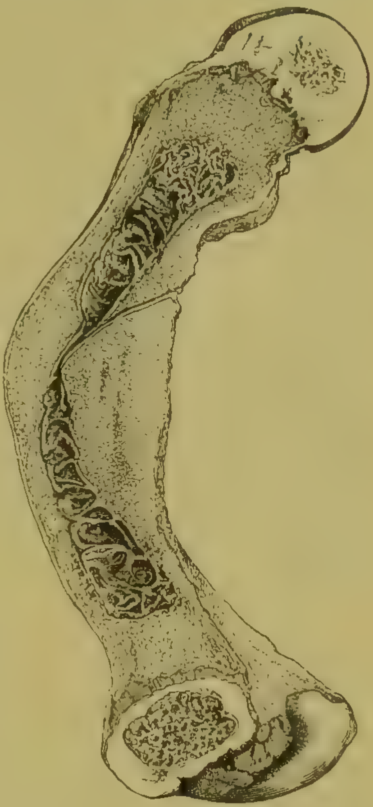

FIG. 45.—A longitudinal section of a rickety femur. (From Erichsen's 'Surgery.')

remaining open till the sixth year. In the **spine** the principal change is an exaggeration of the primary dorsal curve, the spine presenting one long curve from the lowest cervical vertebra to the coccyx. This condition is known as *kyphosis*.

The **Thorax** undergoes most important changes in shape, which often seriously affect the patient in after life. These changes are due to the softness of the ribs and their diminished power of resistance to the pressure of the atmospheric air, so that when the child takes an inspiration and expands the chest wall, the balance between the pressure of the air inside and outside the chest is unequal, and in consequence of this the anterior extremities of the ribs are sucked in and produce a characteristic deformity. The sternum projects forwards, with a deep depression on either side, extending as low as about the eighth costal cartilage. The depression is usually deeper on the right side, owing to the heart being situated to the left of the median line and supporting the ribs and preventing so great a depression on this side. This condition is known by the name of *pigeon-breast*. In consequence of the enlargement of the liver and spleen, the lower ribs are not depressed, but, on the other hand, are pushed outwards so as to produce a transverse furrow at the extremities of the two longitudinal depressions. In this way very considerable deformity of the thorax is produced, which causes impairment of its vital capacity and may seriously interfere with the general health of the child.

The **pelvis** in rickets is often much deformed, the deformity being due mainly to the weight of the spine and trunk pressing on the sacro-vertebral angle and greatly increasing it, so that the antero-posterior diameter of the pelvis is diminished (fig. 171). But in addition to this the weight of the viscera on the venter ilii causes the ilia to become expanded and the tuberosities of the ischia to be incurved. All this produces a narrow and contracted pelvis, which may, in the female, seriously interfere with parturition.

The **long bones** in rickets become bent, generally from an exaggeration of their natural curves, partly by the superincumbent weight and partly by muscular action. This deformity, in the lower extremities, leads to a waddling, rolling gait, and in after life to bow-legs and knock-knees.

Symptoms.—Under the head of symptoms, we have to consider the general symptoms, which may appear before any local changes in the bones are manifest; and secondly, the signs produced by the changes in the bones. The early general symptoms are not always well marked. The child is brought to the surgeon sometimes because, as the mother expresses it, he has been 'taken off his feet,' that is to say, having begun to walk, he seems now unable to do so; or he may be brought because he is restless or fretful; or on account of a 'weak back' the child cannot sit upright. He is frequently fat and well nourished, and apparently, at a first glance, healthy looking, with a bright colour in his cheeks; but a closer inspection will show that the fat is soft and flabby, and that the colour in his cheeks is due to dilated capillaries. The child may, on the other hand, be emaciated. A notable sign of rickets is the tendency there is to sweating about the head, especially during sleep, while the rest of the body is dry. When asleep large drops of sweat will be seen on the child's forehead, and the pillow will be found to be quite wet from the perspiration. The child is restless at night and has a great tendency to throw off the bedclothes, so that it is sometimes impossible to keep it covered. This restlessness is mainly due to great sensibility or hyperæsthesia of the skin, which also causes the child to cry when it is being handled. The digestion is generally defective: the child is subject to flatulency and becomes pot-bellied. There is frequently diarrhœa with intensely offensive stools, and sometimes there is constipation. The tongue is usually white and furred, and the mucous surfaces pallid. Frequently there is vomiting. In the later stages enlargement of the liver and spleen may be detected. The teeth are cut late and in many cases are cut 'crosswise,' that is, not in their proper order of eruption. The urine contains an excess of phosphate of lime, from mal-assimilation, but is otherwise normal.

The changes in the bones show themselves principally in the enlargement of the ends of the long bones, which gives the appearance as if the joints were swollen. This is especially noticeable in the lower end of the radius, and in the ends of the ribs, where they join the costal cartilages; these latter form a row of prominent rounded swellings beneath the skin, which can easily be seen if the child is not too fat, and to which the name of 'rickety rosary' has been given. In addition to this, as the disease advances, the bones bend and form very pronounced curves, and they do not increase in length to the same extent as the normal bones do, and hence the rickety child is stunted and shorter than a healthy child of the same age.

Treatment.—The treatment of rickets consists in, first of all, removing the conditions which have caused the disease, and this may readily be done by attention to proper dieting and hygienic surroundings. Up to the age of nine months the child's diet should consist entirely of milk. If the mother's health is such as to permit her to afford her infant adequate nourishment, the child should be suckled. It is, however, of considerable importance that this point should be definitely ascertained. Many cases of rickets are occasioned in the first instance by the debilitated state of the health of the mother from repeated pregnancies or prolonged suckling, and it is worse than useless in such instances to allow the mother to continue nursing her child, and it is better either to provide a wet-nurse, if one can be obtained, or bring the child up by hand, and feed it with cow's milk which has undergone the process of 'humanising,' or, what answers the same purpose, boiling it and removing the skim, then diluting it with water (1 in 3) and adding a little sugar. Later on in life milk should still form the principal article of diet, but to this may be added raw meat juice, pounded meat, fish, eggs, and a moderate amount of farinaceous food. The child should have plenty of fresh air. Its skin should be kept freely acting by a tepid bath, followed by a brisk rubbing, morning and evening, and it should be clothed in flannel next the skin, especially at night, so that if it kicks the clothes off it may not catch cold. With regard to medicines, cod liver oil is certainly the remedy on which most reliance should be placed, and the fatter the child is the greater the indication for the exhibition of this drug; under its influence the fat, flabby child will often become thinner but much firmer. Cheadle recommends cream as a substitute for cod liver oil. With the oil, steel wine may often be judiciously combined. When the rickety child comes under the care of the medical man before any change in the shape of the bones has taken place, every care should be bestowed to prevent the deformity occurring, by keeping the child in the supine position, especially if the back is inclined to bend, and prevent its crawling or walking. But unfortunately, as this disease occurs principally among the poor, this is what very often cannot be done. Sometimes by fastening a wooden splint to the leg, so that it projects beyond the foot, the child may be prevented from standing. If the deformity has already occurred and the child is still young, say under the age of six, much may be done by carefully applied splints to correct the deformity; but still more may be done by placing the child under the influence of chloroform and straightening the limbs forcibly by manual pressure and then applying splints. This proceeding will have to be repeated at short intervals until the limbs are straight. Sometimes it will happen that in performing this simple operation the bone will give way. No harm is, however, done, but rather good; the limb should be put up in splints in as straight a position as possible, and speedy union will take place. Later in life the deformity is only to be overcome by breaking the bone or dividing it, and in severe cases of deformity one of these operations may be called for. Division of the bone is to be effected either with the saw or chisel by the operation of osteotomy, but the results obtained are not always satisfactory. Some surgeons prefer forcibly breaking the bone subcutaneously by an operation known by the name of osteoclasis. This is done by means of a powerful lever called an osteoclast.

SCURVY-RICKETS

Scurvy-rickets is the name now employed to designate a form of disease which usually occurs in infants under a year of age, in which scurvy and rickets are combined, and which like both of these diseases when occurring singly is due to improper feeding. According to Barlow, 'the scurvy is an essential and the rickets is a variable element' in the disease.

Pathology.—The affection consists in the occurrence of hæmorrhages, more especially under the periosteum, but also from mucous surfaces, in the muscles, and in the subcutaneous cellular tissue. The hæmorrhages under the periosteum seem in a large majority of cases to commence in the highly vascular growing tissue at the ends of the shafts of the long bones, and from thence to travel along the shaft of the bone separating the periosteum from it. Accordingly we find that disjunction of the epiphysis from the shaft of the bone is of common occurrence in this disease.

Symptoms.—The onset is usually somewhat sudden. The child possibly has been ailing for a few days, when a swelling, evidently connected with the bone, starts from the neighbourhood of the epiphysial cartilage and rapidly spreads up or down the limb. It is acutely painful to the touch, and the slightest movement elicits a cry of agony. The limb or limbs, if more than one is affected, consequently lie motionless, so as to simulate paralysis. It is white and pasty-looking, and when separation of the epiphysis has taken place, soft crepitus may be felt. The child is apparently very ill, there is rapid emaciation and great anæmia. The gums may be spongy, or extravasations of blood may occur in various places, under the skin, within the orbit, producing proptosis, or in front of the globe of the eye under the conjunctiva. Hæmaturia has been noted in many cases. If untreated these cases often terminate fatally.

The **treatment** consists in the administration of some fresh raw vegetable—of which perhaps orange juice is the best—with raw meat juice, milk, and plenty of fresh air. The local treatment is perfect rest and fixation of the limbs by bandages.

CHAPTER VII

HÆMOPHILIA

Hæmophilia or the **hæmorrhagic diathesis** is a curious disease, which is characterised by a tendency to severe and obstinate hæmorrhages, occurring spontaneously or after slight wounds or injuries. The disease is therefore sometimes termed the 'bleeder's disease,' and those who suffer from it 'bleeders.'

Etiology.—The only known factor in the production of this disease is heredity, though many other causes, such as gout, tuberculosis, and blood relationship of the parents, have been accredited with producing it. In nearly every case it is possible to trace in the history of the patient his connection with a family of 'bleeders.' The transmission of the disease is, however, very peculiar; for whereas it is much more common in males than in females, the disease is almost always transmitted through the latter, so that it is not handed down by the bleeders, but by the non-bleeders, in a bleeding family. For example, supposing a woman belonging to a family of bleeders bears a number of children of either sex, the boys will be bleeders, the girls in all probability will not; and supposing these children grow up and in their turn beget children, the offspring of the males will not be bleeders, but the offspring of the females will; but of the offspring of the males, the females in their turn will bear bleeders.

Bleeders as a rule are very prolific, but all the males of a family are not necessarily the subjects of hæmophilia, and these do not transmit the disease to their children, so that in this direction the condition dies out; and as the majority of bleeders die before they reach adult life, the disease is not a very common one, at all events in this country. It is more common in Germany, and is said to occur frequently amongst the Jews.

Though the disease is hereditary it seldom shows itself at birth, but not infrequently occurs at the first dentition. The most common period for it to show itself is between the ages of 12 and 17. After this the disease appears to decline, at all events cases are more rarely met with; but this in all probability is due to the fact that bleeders rarely attain adult life, but die of some other disease, which proves fatal on account of the debilitated condition of the patient induced by the hæmophilia.

Pathology.—Nothing is known about the pathology of this disease, and no constant morbid change has been found in those who have died of it. In some instances the heart, and especially the left ventricle, has been found to be hypertrophied; in other cases the walls of the smaller arteries have been believed to be thinner than they are normally. But in the majority of cases these morbid conditions have not been found, and therefore it is probable that they are in no way connected with the disease. Again, the blood shows no peculiarity, and coagulates just as well as the blood from a healthy individual.

It is true that after the hæmorrhage has lasted some time the blood becomes thin and watery, and coagulates imperfectly, but this is only a similar condition to what is produced by any profuse hæmorrhage. In connection with the pathology of this affection, it must be mentioned that it is believed by some to have an obscure relationship with rheumatism. Certain it is that in hæmophilia affections of the joints are by no means uncommon which are not due to hæmorrhage into the joint, but are purely inflammatory in their nature. The exact connection of the two conditions is entirely unknown.

Symptoms.—Profuse and uncontrollable bleeding is the only symptom of this disease, and patients who suffer from hæmophilia present no distinctive constitutional appearance, and, except when suffering from the direct effects of the hæmorrhage, appear to be in a condition of perfect health. It is convenient to consider it under the two forms of the spontaneous and the traumatic, though the two conditions may be combined in the same individual.

The **spontaneous** hæmorrhage occurs from the mucous surfaces, or into joints, or into the subcutaneous cellular tissue. As a rule it occurs without any warning and frequently takes place in the night, whilst the patient is in bed and asleep; sometimes the attacks are preceded by certain premonitory symptoms—a period of excitement, during which the patient is restless, and the heart's action tumultuous and very rapid. It has been stated that some patients have been sensible of an odour of blood in their nostrils for some days prior to an attack. When the bleeding occurs spontaneously from a mucous surface, it most frequently takes place from the nose in the shape of a profuse and uncontrollable epistaxis, which even plugging of the anterior and posterior nares will not stop. After this the next most frequent place from which it occurs is the gums, and then from the alimentary canal.

The respiratory and uro-genital tracts are less frequently the seat of bleeding, at all events in the male; in the female the disease sometimes takes the form of profuse menstruation. When the hæmorrhage occurs into joints, it may be either spontaneous or the result of a slight strain. The joint becomes distended and painful, and very often the skin over it becomes ecchymosed, but there is no increased heat about it, as there is in inflammatory conditions. Any of the large joints may be affected, but the knee is most commonly the seat of the extravasation. Subcutaneous hæmorrhages may occur on any part of the surface of the body, but are more common on the lower extremities than elsewhere. They occur as irregular ecchymoses, sometimes attaining a large size and forming fluctuating swellings under the skin. The sense of fluctuation is the more perceptible because the blood in these cases shows little tendency to coagulate.

The **traumatic** variety may occur after any injury, even of the most trivial character; the scratch of a pin has been known to be followed by a severe attack of bleeding. Perhaps the most common traumatism producing bleeding is the extraction of a tooth. Cases of fatal hæmorrhage after this slight operation are by no means uncommon.

Vaccination does not appear to be often followed by hæmorrhage. This no doubt is due to the fact that the peculiar predisposition of the child does not assert itself until the sixth or eighth month. The bleeding may not only be caused in the traumatic cases by breach of the surface, but may also be induced by pressure, or by strains or wrenches. When the bleeding part can be examined, it will be found that there is a general oozing from the whole surface, and the blood does not spout out from vessels of any size. Its persistency is more its characteristic than its amount.

As the bleeding goes on the patient becomes anæmic, with blanched lips and puffiness about the face, and the blood becomes more and more watery, but as a rule the case does not terminate fatally; when the patient seems to be sinking into a hopeless condition and his vessels to be drained of all their blood, the bleeding will spontaneously cease, and in many cases the patient will recover his natural condition with surprising rapidity. But in this there are variations : some cases recover rapidly and soon appear again in a condition of robust health ; others become profoundly anæmic and remain so and often succumb to some intercurrent disease, or after repeated attacks of hæmorrhage die from loss of blood.

The disease when it occurs in the female is hardly ever so pronounced as in the male. Females are rarely the victims of joint complications, and seldom suffer from those extreme conditions which are met with in the male.

Treatment.—The treatment has first to be considered as regards prophylaxis. And it seems right to say, considering the distinct evidence of heredity, that no man who is a bleeder or woman who has brothers who are bleeders, ought to marry. Beyond this all that can be done is to maintain the health by a nutritious, non-stimulating diet; by warm clothing, gentle exercise, &c., and to avoid as far as possible any accident. The individual who is a bleeder should never use any sharp, cutting instrument—should eat his meals with a silver knife and not even use a pin or a needle. This, however, will not guard him against the spontaneous form of the disease.

As regards the treatment of the bleeding when it occurs, it is generally very unsatisfactory. The general treatment consists in keeping the patient perfectly quiet in bed and freely purging him with saline aperients, unless the hæmorrhage is from the bowel. And although internal medication seems to do little good, it is well to administer either acetate of lead or ergot. Chloride of calcium, which is believed to increase the coagulability of the blood, has also been recommended in these cases. Where the hæmorrhage is external and can be treated locally, pressure combined with the application of perchloride of iron holds out the best hope of arresting it. In the case of bleeding after the extraction of a tooth, the socket should be carefully plugged with lint, saturated with the liquid perchloride of iron, a large plug of lint placed on the top of this, and the jaws bandaged together. When the bleeding is from a wound a tampon of wool soaked in the perchloride should be placed over the wound and firmly bandaged in position, and if the wound is on one of the limbs this should be elevated.

It is scarcely necessary to add that all operations, except those of absolute necessity to save life, should be avoided in an individual who is known to be a bleeder.

CHAPTER VIII

HYSTERIA

Hysteria may be defined as a morbid condition in which certain symptoms are produced as the result of some fault or deterioration in the nutrition of the nervous centres. The name hysteria (*ὑστέρυ*, the womb) was given to the disease because it was believed that the condition of the nervous system was induced by some functional disturbance of the uterus. But this view is no doubt erroneous; in at least half the cases of hysteria in females it is probable that the uterine organs are absolutely normal, and moreover the disease occurs also, though not so frequently, in males, so that the term is etymologically absurd as applied to this sex. Though all cases of hysteria are not due to uterine disturbance, it is probable that there is always some condition of ill health which produces the deterioration of the nervous centres, that excites the disease; sometimes it is anæmia or chronic dyspepsia, at other times mental worry or constant trouble, and in not a few of those advanced in life, habits of intemperance, which may cause the disease. It is impossible in a work like this to describe hysteria adequately in all its multitudinous phases, nor is it necessary to do so, as for the most part cases of hysteria fall under the care of the physician; it will be only necessary to describe, first, an ordinary hysterical fit, and then briefly allude to hysteria in its relation to surgery.

An hysterical fit.—Sometimes an hysterical fit comes on without any exciting cause, but in most instances it is induced by some mental emotion, produced by some shock to the nervous system, either physical or moral. It is mainly characterised by a suspension of the power of control possessed by the higher centres, and results in irregular movements, convulsions, and spasms. The fits frequently begin with a sensation of weight in the abdomen, and the patient complains of a feeling as if some foreign body was present, rolling about and rising upwards to the throat, and producing an intense feeling of suffocation. This condition is known under the name of *globus hystericus*, and is supposed by some to be due to irregular peristaltic contraction of the œsophagus. The sense of suffocation is attended by deep and hurried breathing, and the patient may be observed to clutch at her throat. This is followed by convulsive movements, which usually terminate in a fit of violent laughing or crying, or probably a combination of the two. During the fit the face is flushed, the skin hot, and there is tumultuous action of the heart.

As the convulsive movements cease the heart quiets down, and the patient becomes calm and often falls into a profound sleep or into a semi-conscious state, from which, however, she can be roused. After the fit the patient frequently voids a copious quantity of pale urine. The duration of the fit may vary from a few minutes to several hours, and there may be a succession of fits, extending over several days, the patient remaining in a drowsy state between the attacks.

The **diagnosis** of these fits is generally easy. Epilepsy is the disease with which they are most likely to be mistaken, and it should be borne in mind that there are cases in which epilepsy and hysteria appear to be mixed up together; but the partial insensibility, the absence of any indications of impeded respiration, and the age and sex of the individual, pretty clearly indicate the nature of the disease.

Treatment.—During the hysterical fit the less done in the way of treatment the better. The patient's dress, corsets, &c., should be loosened, so as to give free play to her respiratory muscles, and she should be protected from doing any harm to herself by her convulsive movements. After she has lapsed into the semi-conscious condition she should be allowed to remain so until she recovers naturally, and no efforts should be made to rouse her from it by cold douching, slapping her forehead with a wet towel, and so on. There is no doubt that in this way patients can as a rule be speedily roused from their semi-insensibility, but there is no object in doing it, they will come round in time if left to themselves, and the proceeding seems to do more harm than good.

Hysteria in its relation to Surgery.—It would be impossible to mention all the complaints which hysteria may simulate, for there is scarcely a disease which it does not at some time mimic, and we can only mention the most common ones which it most frequently imitates. Before doing so, however, it will be desirable to review briefly the diagnosis between organic and hysterical affections in general, and this depends mainly on the following points: (1) The pain in hysteria is intermittent, not periodic as in neuralgia. At one minute the patient will be complaining of the most intense pain, and at another, especially if her attention is withdrawn from the part by engaging her in conversation which interests her, she will forget her pain, and talk and laugh freely, quite forgetful that a few minutes before she was writhing in agony. Again, the pain is out of all proportion to any local changes in the part affected and often varies in its situation. If the patient is asked to indicate the exact spot where the pain is situated with one finger, she will readily point to one particular part, and five or ten minutes after, if asked the same question, she will point to another.

(2) The tenderness of hysteria is superficial and partakes more of the character of an hyperæsthesia rather than a deep-seated pain, though the part supposed to be affected may be deeply seated. The slightest touch with the finger will often elicit a cry of agony, while if the patient's attention is engaged considerable pressure may be made on the same spot without causing any evidence of pain.

(3) The course of the disease is also a point which should be taken into consideration by the surgeon, and will often be of value to him in arriving at a correct diagnosis. A patient may have suffered from an hysterical affection say of a joint or the spine for some long time, and still there will be no indication of any gross lesion in the part, though it is true there may be and often is a little swelling. But it is beyond the range of probability that organic disease in these parts could have existed for some time, possibly for years, without producing changes which would be apparent to the most casual observation.

(4) The general condition of the patient should also be taken into consideration. Though there is nothing distinctive about the hysterical

individual, and she may be either apparently in a condition of perfect health, plump and ruddy, or, on the other hand, wan and emaciated, with an anxious expression and a sallow face, still there is usually some evidence of her being of a neurotic type. She may belong to a neurotic family, or she may be emotional or irritable or morbidly sensitive. In addition to this there is often evidence to be obtained of her having suffered from globus hystericus or from hysterical headache, which consists of a gnawing pain, localised to one spot, generally over one eyebrow or on the top of the head near the sagittal suture. The pain has been likened to a nail being driven into the head, and is therefore known under the name of *clavus hystericus.*

Hysterical spine.—This is a form of disease which simulates Pott's disease of the spine. A patient will complain of a fixed intense pain in the back, with a sense of constriction round the belly. Pains in the lower limbs may be complained of, with weakness or perhaps inability to walk or stand. There may be difficulty in voiding the urine. In spite of this, the patient may be apparently in perfect health, without any wasting or defect in nutrition. Upon examining the spine, though severe pain is complained of on touching it, this pain is not always felt at the same spot, and is greater upon touching it lightly than when deep pressure is made. No pressure is elicited by jarring the spine as in making the patient jump off a stool to the ground. On causing the patient to flex her spine, the painful vertebra is found to move freely on the others.

Hysterical joint.—Perhaps the most difficult class of hysterical cases with which the surgeon has to deal as regards diagnosis are hysterical affections of the joints. This is, no doubt, due mainly to the fact that in these cases the joint is fixed and immovable, and that there is often considerable puffy swelling, caused by local applications which have previously been applied. The patient complains of great pain in the articulation, and any attempt to move the joint elicits a cry of agony; but in the majority of cases it will be found that the limb is fixed in the extended position, which would not be the case if there were any actual disease, and there are no sudden startings of the limb at night. Under the influence of an anæsthetic the joint moves freely and smoothly. In many cases the absence of any heat about the joint is an important indication. If the hand is laid on a joint the seat of some chronic inflammatory disease, a sensible increase of heat will be perceptible; but in cases of hysterical disease the joint is usually of the same temperature as other parts of the body. But this is not quite true of all cases; for in some hysterical joints a considerable amount of heat is sometimes present at one part of the day, generally in the evening. Another point in the diagnosis is the fact that pressure of the two articular surfaces together is not attended by any increase of pain. Supposing the knee joint is the one affected, pressure on the heel will not cause the patient to give any evidence of increased pain.

Hysterical breast.—A young woman will complain of great pain in her breast, and state that even the pressure of her clothes is insupportable. On examination the breast will be found to be larger than the other, and the skin over it tense. The gland tissue has an irregular, knotty feel, and one lobule may be especially prominent and particularly painful, exciting fears in the patient's mind of cancer. It will be found, however, that if the palm of the hand is placed flat on the supposed lump, no tumour can be perceived ; this, and the evidently neurotic condition of the patient, and the superficial nature of the pain, so that the patient flinches at the slightest touch, is generally sufficient to establish the diagnosis.

Abdominal troubles are very common in hysteria. They may present themselves in many different ways. One of the most common, and especially so in the male, is a morbid condition about the action of the bowels. This possibly is a condition of hypochondriasis, but is so closely allied to hysteria that it can scarcely be differentiated from it. At one time the bowels are confined, and the patient at once fancies himself the victim of obstruction, or he takes large quantities of purgatives and gets pain in the abdomen, and in consequence suspects he has got cancer. In other cases of abdominal trouble, the symptoms of ulcer of the stomach are simulated. Again, flatulent distension of the abdomen with eructations is complained of, and causes the patient intense misery. Finally, the so-called 'phantom tumour' of the abdomen is an occasional form of hysteria. The patient complains of a swelling in some part of the abdomen, and, on examination, what feels like a fairly defined tumour, usually just to one side of the linea alba, can be felt. It is generally resonant on percussion, and is due to contraction of the fibres of the rectus muscle. It entirely disappears during anæsthesia.

Retention of urine.—In the female retention of urine is a not unfrequent way in which hysteria shows itself. The young woman will declare her inability to void her urine. She will express great desire to do so, and will complain of great pain in consequence of not being able to accomplish her wish. On examination, the bladder will be found to be full, forming a distinct tumour in the hypogastric region. In the great majority of cases these patients may be safely left alone, and after a time the urine will be voided. The passage of a catheter only leads to a recurrence of the evil. On the other hand, continued retention may lead to chronic cystitis or to atony, so that some little discrimination is required in dealing with these cases.

Sexual troubles.—In the male, certain sexual troubles may be classed as hysterical. These are either fear of impotence, or dread of the evil effects of too frequent seminal emissions. They generally take their origin either in a slight varicocele or in some chronic prostatitis, which occasions a discharge of shreds of mucus from the urethra, and this is supposed to be semen.

Treatment.—The treatment of some of these hysterical conditions is often one of the most difficult problems that the surgeon has to solve. On the one hand, if he makes light of the matter, and assures the patient that there is nothing wrong with her, he at once destroys her confidence in him, and all his efforts to regain it will be useless ; but if, on the other hand, he makes too much of the disease, he only enhances in the patient's mind its importance, and thus serves to perpetuate the condition. A great deal depends, in the treatment of hysteria, upon the surgeon's success in obtaining the confidence of his patient, and in fixing in her mind the belief that he understands her malady and is able to cure it. He should therefore spare no pains to convince her that the disease is understood, and that if his directions are carried out a cure may confidently be looked forward to.

This having been done, any probable cause of the disease or condition of bad health should be attended to. If the menstruation is irregular, defective, or excessive, it should be corrected; if the bowels are torpid, active purgation should be resorted to; if dyspepsia is present, it should be treated. In short, the state of the general health should be inquired into, and the patient prescribed for according to the circumstances of her case. In obstinate cases, the employment of the Weir-Mitchell plan of treatment appears to be attended by very favourable results. This, however, belongs more to the domain of medicine than surgery.

It will be seen, therefore, that success in treating hysteria depends more on carrying out general principles than in any formal line of treatment.

CHAPTER IX

TUMOURS

Perhaps there is no word for which so many definitions have been given in surgical nomenclature as the word 'tumour,' and none of them are quite satisfactory. Still, we all know what we mean when we speak of a tumour, and it is not necessary to labour to give an exact definition of the word. By it we mean a new formation, organised or partly organised, and not resulting from inflammation alone. This new formation has no tendency to undergo resolution, but, on the other hand, tends to grow, and does not, as far as our present knowledge goes, owe its origin to any infective cause, or belong to that class of new growths which are known as the infective granulomata, such as gummata, tubercles, actinomycosis, &c. Tumours are derived from the tissues in which they originate, and resemble this tissue either in its complete or embryonic state. Thus, when a tumour grows from connective tissues, as bone, cartilage, fat, the tumour is composed of these structures; or it may consist of embryonic connective tissue, that is, of elements indistinguishable from the rudimentary tissues found in the embryo; or when the tumour grows from epithelial tissues, it consists of cells like those constituting epithelium.

As, however, this new growth increases in size, it does not always behave in the same way to the tissues from which it originates, and the different behaviour of tumours in this respect has led to their division into two classes, the *homologous* and the *heterologous*. The **homologous** tumour simply grows by pushing on one side the tissue in which it originates. It is therefore always more or less circumscribed, is generally surrounded by a capsule formed of the condensed and compressed tissues, and remains limited to the structure from which it took origin. These tumours are generally innocent in their nature. The **heterologous** tumour, on the other hand, infiltrates, destroys, and replaces the structures in which it originated, and from them extends into neighbouring tissues of many different varieties. It is not therefore so distinctly circumscribed, and it is often impossible to say where the morbid growth terminates and the normal structure begins. These tumours are generally malignant.

These observations lead us to say a word or two on the terms 'innocent' and 'malignant.' These words are used in a purely clinical sense, without any reference to the anatomical structure of the growth. The term **innocent tumour** is applied to those growths which do not return if completely removed, which do not infiltrate surrounding structures, and do not affect the lymphatic glands or other parts of the body. A tumour may, however, be innocent and may yet destroy the life of the patient by the increase of its bulk, by its situation, or by inducing exhaustion from sloughing or ulceration. The term **malignant tumour** is applied to those growths which invade all the textures of the part in which they grow, and are not often encapsuled. They grow rapidly and influence the general health. They affect neighbouring lymphatic glands, and through the blood or lymph stream disseminate in distant organs. They are prone to return after complete removal. If left to run their course, they soften and ulcerate, cause cachexia, and finally death from exhaustion. The terms 'cancer' and 'malignant tumour' are not synonymous, for though all cancerous tumours are malignant, all malignant tumours are not necessarily cancers, or, as they are termed anatomically, carcinomata.

Classification.—Tumours are now almost always classified upon an anatomical basis, which is not only in accordance with that which is employed in other scientific classifications, but also enables the student to trace the origin of the growth from the pre-existing structures from which it sprang, and to understand the relationship which it bears to other tumours which resemble it. In the first place, all tumours may be divided into two great groups, which are distinctly separate from each other: (1) Fluid tumours (cysts); (2) Solid tumours.

CYSTS OR CYSTIC TUMOURS

A **cystic tumour** may be defined as a closed sac, containing fluid or semi-fluid contents. The sac wall is composed of connective tissue, and may or may not be lined with epithelium according to its origin. These cystic tumours must not be confounded with cysts *in* tumours, i.e. cavities formed in the substance of solid tumours as the result of mucoid degeneration. These cavities have no true cyst wall, and will be considered in connection with the solid tumours in which they occur.

Cystic tumours may be divided into:

I. Cysts formed by the distension of pre-existing tubes or sacs.
II. Cysts of new formation.
III. Cysts of congenital origin.

I. **Cysts formed by the distension of pre-existing tubes or sacs.**—These cystic tumours are caused by the collection of fluid in a pre-existing cavity, which is either a closed sac, so that the fluid as it collects cannot escape and therefore forms a tumour, or else a cavity or sac the duct of which becomes choked, so that the natural secretion becomes retained and forms a tumour. This naturally divides this class of cystic tumours into two groups, which are named respectively (*a*) exudation cysts; (*b*) retention cysts.

(*a*) **Exudation cysts** are those cases of cystic tumours where a collection of fluid takes place in a closed sac, without any outlet, that normally secretes a small quantity of fluid, which is absorbed as rapidly as it is secreted and in which therefore no accumulation takes place. Owing to some cause producing an increased secretion or interfering with the natural process of absorption, a collection of fluid in the sac takes place, and an exudation cyst is produced. To this class belong many different conditions, which are not as a rule spoken of clinically as cystic tumours, though undoubtedly they are caused in the way mentioned above, such as dropsy of a joint, collections of fluid within serous cavities, spina bifida, &c. The best examples of exudation cysts are to be found in bursal tumours, which consist of exudation into the sac of a bursa; ganglia, formed in connection with the sheaths of tendons, are also examples of this form of cystic tumours. These conditions will be considered in the sequel.

(*b*) **Retention cysts.**—These form a much more definite and distinct group of tumours. They consist of the accumulation of the natural secretion in some duct or acinus of a gland, owing to the fact that the orifice by which it is naturally got rid of has become obstructed. In consequence of this the accumulated secretion distends the duct or acinus and forms a fluid swelling. The condition is not one, however, of simple dilatation alone, for as the disease progresses the wall of the cyst, which was originally the wall of the duct or acinus in which the secretion is retained, becomes thickened by the growth in it of new fibroid tissue, the result of the irritation set up. Hence the walls of some of these cystic tumours which have existed for some time may become exceedingly dense and thick.

The best example of these retention cysts is found in the *sebaceous* or *atheromatous* cysts. These arise from the occlusion of the orifice of a sebaceous gland on the surface of the skin. The secretion of the gland going on, and being unable to escape, collects in the interior of the gland and forms a cystic tumour. These tumours are especially common on the face and scalp, but may occur on any part of the body. They are situated immediately under the skin, which is usually attached to them at one spot when the tumours occur on the scalp or trunk; but when they occur on the face, the skin is adherent to the surface of the tumours and cannot be separated from them. The thickness of the sac wall varies very much: when they occur on the scalp it is often so thick and dense as to convey to the hand the sensation of a solid tumour; when, on the other hand, they occur on the face, the sac wall is often exceedingly thin and delicate. It consists of fibroid material, lined by a layer of actively growing epithelial cells. The contents of the sac consist of an inspissated creamy material of a peculiarly offensive odour. Sebaceous tumours vary much in size; some are as small as a pin's head, others as large as an egg, and they may even attain greater dimensions than this. They form smooth, round, circumscribed tumours, movable on the parts beneath, and, except when situated on the face, movable under the skin. They are usually soft and putty-like to the feel, and are often covered with a network of dilated capillaries, which ramify in the thinned skin over them and give to them a dusky red hue. Occasionally a small black spot may be detected on the surface of the skin over them, where the occluded duct opened, and the tumours are usually more adherent to the skin at this point. They are frequently multiple, especially when they occur on the scalp, and they grow slowly or may remain stationary for years. They cause no pain, nor does the patient suffer, as a rule, any inconvenience from them except from their unsightliness. When irritated, a sebaceous tumour may inflame and suppurate. The skin over it becomes thinned and ulcerates, and the exposed sebaceous material putrefies. Sometimes suppuration takes place in the tissues around, and the whole cyst is thrown off and the wound heals, leaving a puckered scar; at others, the cyst wall becomes thickened and very vascular and forms a nodulated ulcer, with everted edges, which has a tendency to spread and much resembles an epithelioma, but there is no implication of the glands, and if removed it does not recur. Again, a sebaceous tumour may form a peculiar horny growth. Some of the sebaceous matter exudes through an aperture on the surface, and drying forms a scab; under this a fresh exudation takes place and pushes the original scab before it, until by a repetition of this process a horny growth, sometimes several inches in length, is formed (fig. 46), consisting of the dried sebaceous material, which has become black from exposure to the air.

The **treatment** of these tumours consists in their removal. Occasionally they may be cured by inserting a fine probe into the occluded duct, so as to open it up, and then periodically squeezing out the contents. Generally, however, if the tumour is of any size, or at all unsightly, it is better to remove it; but if it is small, not increasing in size, and producing no disfigurement, it may safely be left, the patient being told that it may at any time begin to grow without any assignable cause, and that then it will need removal. The mode of operating differs somewhat according to the situation of the tumour. When it is on the scalp, the sac wall is thick, and all that is necessary is to expose the tumour by an incision and shell it out with the scoop of a director. No sutures are required afterwards, as the edges of the wound fall into apposition, and all that is necessary is to cover it with a pad of antiseptic gauze, which is bandaged on and left in position for three or four days, when the wound will be found to be healed. When the tumour is situated on the face, it may require dissecting out, or, on the other hand, it may be possible to drag it out by seizing it with a pair of forceps. It should be exposed by an incision and an attempt made to drag it out with the forceps; should this not succeed, it must be dissected out, care being taken to remove every particle of the cyst wall, otherwise a troublesome sinus will be left. These wounds require suturing, so as to leave as little scar as possible. When sebaceous tumours occur on other parts of the body they generally require dissecting out.

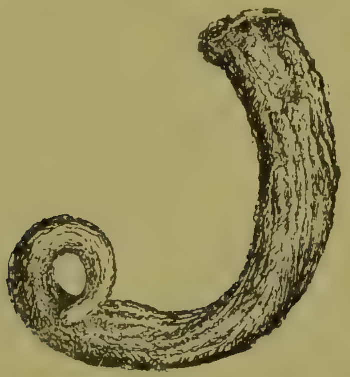

FIG. 46.—Horny growth removed from the face. (From the Museum of St. George's Hospital.)

Other examples of retention cysts occur on the mucous surfaces, originating in the same way by the retention of the natural secretion of some secreting surface. The best example of this is a *ranula*, which arises from the retention of the secretion in one of the mucous crypts in the floor of the mouth. They will be described with diseases of that part of the body. Many cases of *dropsy of the antrum* belong to the same class, and are due to the same cause—retention of the secretion in one of the mucous crypts of the antral cavity. *Cysts in the labia* of the female from collection of the secretion in one of the glands of Bartholin, or more rarely in the male the collection of the secretion in one of Cowper's glands, give rise to a retention cyst.

Finally, a third example of retention cyst may be found in the dilatation of some large duct of a gland, the orifice of which has become occluded and the secretion of the gland retained in the duct. A good illustration of this is the galactocele of the female breast during lactation. The orifice of one of the milk ducts becomes obliterated, and the milk which is secreted, being unable to find an exit, collects in the tube and forms a retention cystic tumour.

II. **Cysts of new formation.**—Cysts of new formation comprise a much larger and more important group of cystic tumours than those we have just been considering. They may be conveniently discussed under three different groups: (*a*) Simple or serous cysts; (*b*) Blood cysts; (*c*) True cystic tumours; that is, tumours where the existence of the cyst is an essential of their growth and not an accidental coincidence.

a. **Simple or serous cysts.**—The simple or serous cyst may occur in any part of the body. It consists of a single cavity formed of a thin-walled membrane lined by a layer of flattened epithelium, and containing a slightly viscid, serous fluid. These cysts are believed to originate in the expansion and fusion together of some of the spaces of ordinary areolar tissue by an accumulation of fluid in them. Around this fluid the connective tissue becomes condensed and forms a sac wall, and thus a cystic tumour is produced. False bursæ, formed where there is pressure or friction, as in a bunion, constitute cystic tumours of this class.

b. **Blood cysts.**—Blood cystic tumours are of two different kinds. One is where condensation takes place around an extravasation of blood, probably as the result of some slight degree of inflammation. The products of this inflammation become organised and converted into a fibrous membrane, which incloses the extravasated blood. The blood then undergoes change, which results in the formation of a clear serous fluid, and thus a cystic tumour is formed. Cysts in the sub-dural space of the brain are occasionally formed in this way from extravasations of blood after injury to the head (fig. 221). The other form of blood cyst is not common. It principally occurs in the neck, when it is known under the name of *hæmatocele of the neck.* It consists of a thin-walled cyst, sometimes single, sometimes multilocular, containing pure blood. The mode of origin is uncertain, but it is supposed by some to originate in a nævus. The chief peculiarity about these cysts is that if they are tapped they at once fill again; and if incised they bleed furiously, although no connection can be traced with a vessel of any size. The blood appears to come from an exceedingly vascular sac wall; for its removal is at once followed by a cessation of the hæmorrhage. The treatment consists, therefore, in removal of the cyst, or sometimes tapping and the injection of liquid perchloride of iron will suffice.

c. **True cystic tumours.**—These are tumours in which the presence of the cyst or cysts is an essential part of the growth. Generally many cysts are developed in close proximity to each other, and these becoming more or less fused together constitute compound, i.e. *multilocular*, cystic tumours. They are especially common in the ovary, testicle, and breast. In many of them secondary growths spring from the lining membrane of the cysts, which may partially or completely fill them. The tumours are then spoken of as *proliferous cystic* growths. These cystic tumours consist of an external envelope of connective tissue, lined by epithelium which usually resembles that of the part from which the cyst is formed, and the secondary growths, when they exist, spring from a layer of vascular embryonic tissue, situated beneath the epithelium; between it and the external wall of the cyst. These secondary growths may spring from one or many parts of the wall of the parent cyst, and when first appearing look like so many papillary growths. They project into the cyst, and are coated with its lining epithelium. As they grow, they coalesce and form a solid mass which may eventually completely fill the parent cyst, and making their way through its walls may burst through the skin and eventually form a fungating mass. In other cases these papillary intra-cystic growths may themselves become cystic, and in this way we get daughter cysts formed within the parent cyst. This form of cystic tumour is known as the *cystigerous* cystic tumour. And by similar processes to those by which these secondary cysts are formed, tertiary cysts, or cysts within the secondary cysts, may be developed. These various forms of cystic tumours will be discussed in connection with the diseases of the organs in which they are principally found—the ovary, breast, and testicle.

III. **Cysts of congenital origin.**—Cysts of congenital origin include a large and diverse group of tumours, which may be considered under three different heads: (*a*) Cysts due to errors in development; (*b*) Dermoid cysts; (*c*) Cysts due to defects in the lymphatics.

a. **Cysts due to errors in development.**—Among cystic tumours due to imperfection in the process of development one must include, first of all, such tumours as spina bifida, meningocele, encephalocele, &c., which arise from arrest in approximation of the two lateral parts of the embryo in the mesial line; these, however, will more appropriately be considered with diseases of the back and head. Secondly, under this category we also include those cysts which are due to an imperfection in the obliteration of fœtal structures, which under normal circumstances become obliterated in the process of development. As an example of this may be mentioned the cystic hydrocele of the cord, which arises from a collection of fluid in an unobliterated portion of the funicular process of the tunica vaginalis.

b. **Dermoid cysts.**—As dermoids or dermoid cysts are included those cystic tumours composed of structures which naturally belong to the skin or mucous membranes, but which occur in situations where these structures are not found under normal circumstances. Until very recently dermoid cysts were held to include only a single group of tumours, which were formed by an involution of the epiblast of the embryo in a manner which will be described immediately; but at the present time, mainly through the work of Bland Sutton, dermoids are arranged into three groups, which are named by him: (α) Sequestration dermoids, (β) Tubulo-dermoids, (γ) Ovarian dermoids.

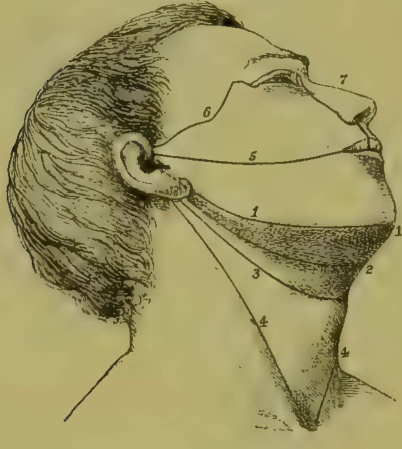

FIG. 47.—Head and neck of an adult, with diagrammatic lines, representing the situation and direction of the branchial and other clefts. 1, 2, 3, 4, first, second, third, and fourth clefts; 5, intermaxillary cleft; 6, fronto-orbital fissure; 7, naso-maxillary fissure.

α. **Sequestration dermoids.**—These were the only class of dermoids which were formerly recognised, and they are formed, as stated above, by the inclusion of a portion of epiblastic tissue in the deeper layers of the blastoderm.

It will be remembered that the external layer of the blastodermic membrane, the epiblast, forms the surface epithelium of the body. As the embryo is developed and coalescence of skin surfaces takes place, especially in the middle line, where the opposite halves of the body wall join each other, and also in the situation of the branchial clefts, it is easy to understand that a small portion of this epiblastic tissue may be included or shut in at the point of junction, and being nipped off from the rest of the surface epithelium comes to be buried, in the process of growth, in the deeper tissues. Here, isolated from the tissue from which it originated, it undergoes developmental processes and becomes converted into a closed cavity lined internally with structures proper to the skin, and thus forms a dermoid tumour. These tumours are therefore found in situations where this coalescence of skin surfaces takes place, namely, in the middle line of the body and at the points of coalescence of the branchial clefts. The accompanying figure by Cusset shows where these junctions take place, and where these tumours may be expected to be found (fig. 47). The most common situation of all is in the fronto-orbital fissure at the outer angle of the orbit (fig. 48). In the middle line of the body the most common situation for them to appear is in the lumbo-sacral region, where they may be mistaken for spina bifida.

Sequestration dermoids consist therefore of cysts, the wall of which is formed by the buried epidermis, and their contents may consist of hair, the secretion of sebaceous and sweat glands in the wall of the cyst, and desquamated epithelium. Very frequently, however, it will be found that they contain nothing but a clear fluid, in which is a ball of coiled-up hair. These tumours continue to grow with the growth of the individual, but rarely give rise to much inconvenience. They to a great extent resemble in appearance the atheromatous cyst, but they may be diagnosed from them by their situation, by their not being connected in any way with the skin, and by their deeper position in the subcutaneous tissue.

Another form of sequestration dermoid is known under the name of *Implantation cysts*. These are small cysts exactly resembling the dermoid cysts just described both in structure and contents, but occurring on the limbs, trunk, head, and face, in situations where there has been no coalescence of skin-covered surfaces during development. The exact origin of these was for a long time doubtful, but there now seems every reason to believe that they are caused by small particles of epidermic structures being driven into the deeper tissues on the point of some instrument which inflicts a punctured wound, such as a bradawl or a pin, &c. The small portion of implanted epidermis develops in the process of time into a cyst. These tumours are especially common in the hands and fingers, which are positions in which such injuries are liable to occur, and cases have been recorded where they have been found in the iris and cornea, after punctured wounds of the eye.

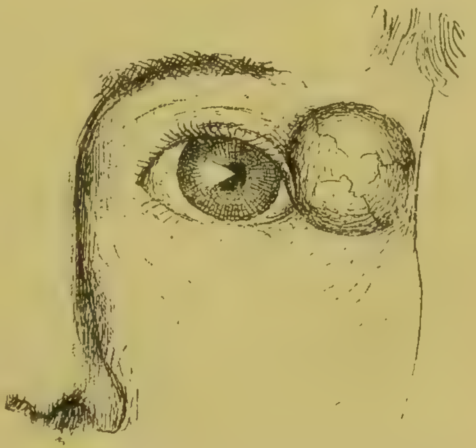

FIG. 48.—Dermoid cyst at the outer angle of the orbit. (From a drawing in the Museum of St. George's Hospital.)

β. **Tubulo-dermoids.**—A second form of dermoids is the tubulo-dermoid, which consists of a collection of fluid in an embryonic canal, which under normal circumstances undergoes obliteration, but having failed to do so, an accumulation of fluid takes place in its interior.

According to Bland Sutton, three of these obsolete canals are occasionally the source of dermoids; these are the thyro-glossal duct, the post-anal gut, and the branchial clefts.

The *thyro-glossal duct* in the embryo passes from the foramen cæcum of the tongue to the isthmus of the thyroid body. It usually becomes obliterated and disappears. Should it not do so, it may form a dermoid under the tongue situated deeply between the two genio-hyo-glossal muscles. The *post-anal gut* of the embryo may give rise to dermoid cysts, in consequence of its non-obliteration. These are situated in the loose connective tissue between the rectum and the anterior surface of the sacrum and coccyx, or may sometimes be found in the rectum itself, attached to its mucous membrane. In the same way, a part of one of the *branchial clefts* may remain unobliterated and may form a dermoid cyst. The most common situation for these is beneath the deep fascia at the anterior border of the sterno-mastoid muscle. These tumours, like many other conditions arising from arrest in development, have a tendency to run in families. Some years ago I saw a patient with one of these cysts,

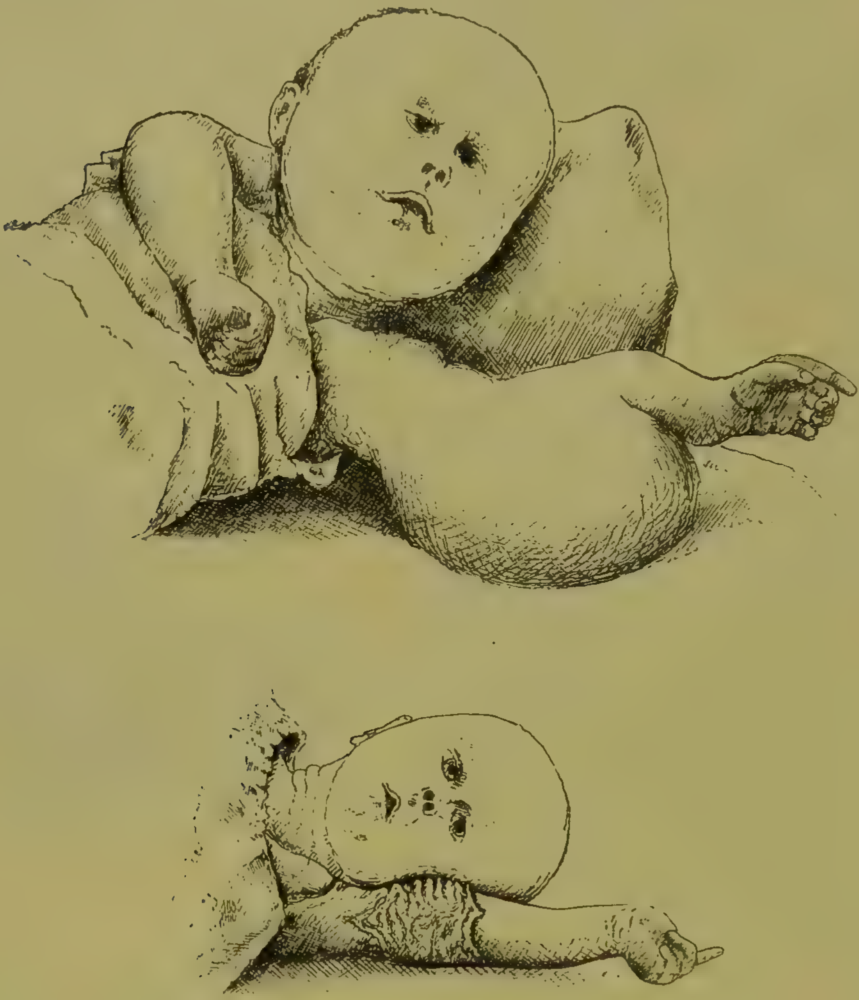

FIG. 49.—A large cystic hygroma of the arm in an infant cured by a single tapping. The arm is shown before and after operation. (From a photograph.)

who told me that his mother, his aunt, and two of his sisters suffered from a similar condition.

γ. **Ovarian dermoids.**—The ovarian dermoids differ in several respects from the other classes of dermoids. Unlike the rest, they are not congenital, at all events no evidence has yet been brought forward to prove that they are so, and no instances have been recorded in which they have been found during the first year of life. They originate from the epithelium lining the ovarian follicles, and often attain a very large size, and in this also they differ from the other forms. They are also peculiar in the greater variety and greater development of the dermal structures which they contain: bone, cartilage, teeth, large quantities of hair of unusual length, gland structure, horn and nails are not uncommonly found in these cysts. Dermoids are sometimes found in the peritoneal cavity, connected to the mesentery and omentum. They are believed to be ovarian dermoids, which have become detached from the ovary.

c. **Cysts due to defects in the lymphatics.**—These cysts, which are congenital, though not always noticed at birth, are named *cystic hygromata.* They are found most frequently in the neck, but may occur in any situation, being contained generally in the subcutaneous tissue, but occasionally found in the cellular tissue in the region of the kidney. They consist of a number of thin-walled cysts, sometimes communicating with each other, at others forming completely closed sacs, held together by areolar tissue, in which there is often a certain amount of fat. The walls of the cysts are composed of areolar tissue lined by a single layer of endothelial cells. The contents are usually clear and serous, or it may be blood-stained, and occasionally solid masses of lymph are found lying loose in the cysts. They are supposed to be caused by dilatation of the lymphatic spaces.

They form lobulated tumours, which distend the skin and are sometimes translucent, especially when they occur in the neck, where they sometimes attain a large size, constituting what is called *hydrocele of the neck.* They are liable to be mistaken for subcutaneous nævi, but they are not diminished by compression. Occasionally they may be cured by tapping, with or without the injection of tincture of iodine; but their removal, when it can be undertaken without undue risk, is the plan of treatment to be advised (fig. 49).

SOLID TUMOURS

Solid tumours for purposes of classification and description may be conveniently divided into four groups, according to their anatomical structure:

1. A group in which are classed together all those tumours which are composed of one of the different forms of fully developed connective tissue.
2. Those tumours which are composed of one of the more complex tissues of the body, such as muscles, blood-vessels, nerves, or gland tissue.
3. Tumours composed of embryonic connective tissue; and
4. Tumours composed of cells of an epithelial type in a fibrous stroma.

GROUP I. CONNECTIVE TISSUE TUMOURS

Connective tissue is found in many different forms in the human body, as ordinary fibrous connective tissue, adipose tissue, cartilage, and bone: and we shall find that there are tumours which are composed of each of these different structures, and that in addition to these there is a tumour which is composed of a tissue resembling the Whartonian jelly of the umbilical cord of the fœtus, which is also a form of connective tissue and which has therefore to be included in this group.

The various tumours, therefore, which we shall have to consider in this section, corresponding to these different varieties of connective tissue, are the following:

I. Fibrous tissue (Fibroma).
II. Adipose tissue (Lipoma).
III. Cartilage (Chondroma).
IV. Bone (Osteoma).
V. Mucoid tissue (Whartonian jelly) (Myxoma).
VI. Neuroglia (Glioma).

I. **Fibroma.**—The term fibroma is applied to those tumours which consist entirely or almost entirely of fibrous tissue, and in which the cells are of the type of the connective tissue corpuscles. In many other tumours fibrous tissue forms an important, though by no means the only, constituent of the growth, and these are not included among the fibromata. Thus among innocent tumours the lipomata consist of lobules of fat, contained in a fibrous envelope; and among malignant tumours, the carcinomata consist of a fibrous stroma in which epithelial cells are contained. In many tumours, indeed, the fibrous tissue forms such an important constituent that the prefix 'fibro' is applied to the proper name of the tumour to indicate this excess of fibrous tissue, as the fibro-adenoma and the fibro-lipoma.

The fibromata are not common. They vary much in consistence, so much so that they are commonly divided into two classes, the soft and the hard fibromata; but between the two there are numerous gradations, though their structure is essentially the same.

The **hard fibromata** are found principally in the subcutaneous tissue, or growing from periosteum or in connection with nerves. They are round or oval, smooth on the surface, and of uniform consistence. They are usually encapsuled, and on section present a pearly-white glistening appearance, with numerous white bands, which have a tendency to arrange themselves in whorls. Under the microscope they present nothing but ordinary white fibrous tissue, with connective tissue corpuscles uniformly distributed among the fibres. Clinically these tumours are slow in growing, and rarely attain a large size. They are distinctly circumscribed and freely movable, except when connected with periosteum. They are hard and firm, but at the same time there is a degree of elasticity about them which serves to distinguish them from chondromata and osteomata. They are not usually painful, but one particular form which grows in the deeper layer of the skin and is known as the *painful subcutaneous tumour* is exquisitely painful; so, also, is the fibroma growing around the cut end of a nerve, as in a stump. This form is known as a *false neuroma*. The fibromata are usually single, but the false neuromata are often multiple.

The **soft fibromata**, sometimes called fibro-cellular tumours, grow from the subcutaneous tissue, being especially common in the scrotum of the male and the labia of the female. They also grow from the submucous tissue, as that of the gums, forming an epulis; or from that of the nasal cavities, constituting one form of nasal polypus. In addition, intermingled with muscular tissue, they grow from the uterus, constituting uterine fibroids. Growing from the subcutaneous tissue of the trunk generally, they often form a large pendulous tumour, which is known as *molluscum fibrosum*. Like the hard variety they are encapsuled, and when cut into are found to contain a considerable quantity of serous fluid. When examined microscopically they display a number of wavy bands of white fibrous tissue, but rarely contain any yellow elastic fibres; in the midst of the fibres are ordinary connective tissue cells. These tumours are soft, rounded, circumscribed masses, often lobulated. They grow much more rapidly than the hard fibromata, but without pain, and often attain a considerable size.

Molluscum fibrosum (pachydermatocele). These tumours consist of an overgrowth of the skin and subcutaneous tissue, which hangs in pendulous folds, especially from the neck, buttocks, and thighs (fig. 50). They consist of ordinary connective tissue, which is often infiltrated with large quantities of fluid from œdema, and contain large blood-vessels, which when cut bleed furiously.

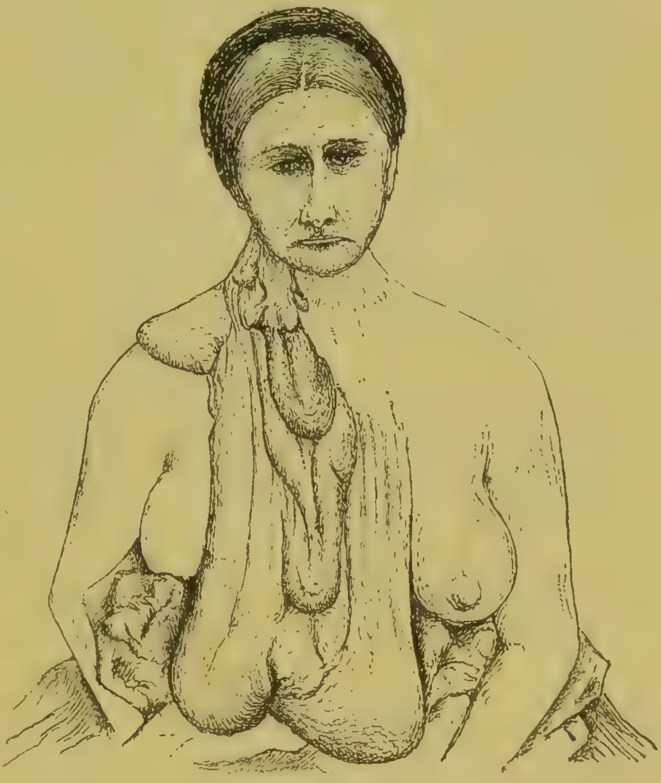
FIG. 50.—Molluscum fibrosum. (From a drawing in the Museum of St. George's Hospital.)

The fibromata are subject to certain retrogressive changes. They are liable to undergo mucoid degeneration in their centre, and thus to form a cyst in their substance. This is an example of a cyst *in* a tumour. They also sometimes calcify; this is especially the case with the uterine fibroids, which may become converted into hard calcareous masses. The molluscum fibrosum may sometimes undergo ulceration and sloughing, or the skin over it may slough, from deficient blood supply, exposing the tumour.

Treatment.—The only treatment of fibromata, if any treatment is necessary, is removal. In some instances, especially in regard to the hard fibromata, which may remain stationary for years, and are perfectly painless, it is often expedient to leave them alone, especially if they are not situated on any exposed part of the body and are not therefore unsightly. With regard to molluscum fibrosum, care must be exercised in their removal, on account of hæmorrhage. The pedicle should either be divided gradually and with care, each vessel being seized with artery clips as it is wounded, or the base of the tumour should be ligatured in pieces before the growth is removed. The fibromata are innocent tumours, and do not return if removed.

II. **Lipoma.**—The lipomata are tumours composed of fat, and occur under two forms, the circumscribed and the diffused.

The **circumscribed** lipoma is the commonest of the innocent tumours. It is principally situated in the subcutaneous tissue, but it may grow from the connective tissue of any part of the body; deeply seated in the intermuscular planes; in the cavity of the abdomen; in the spinal canal in connection with the membranes of the cord; or from the periosteum of bone. It is simply a mass of fat, differing in no respect from ordinary adipose tissue (fig. 51). It is inclosed in a capsule formed of condensed areolar tissue, which when the tumour is subcutaneous is attached to the skin by fibrous bands, so that the integument becomes puckered or dimpled when it is tensed over the tumour. The fat cells when examined microscopically often present crystals of the fatty acids.

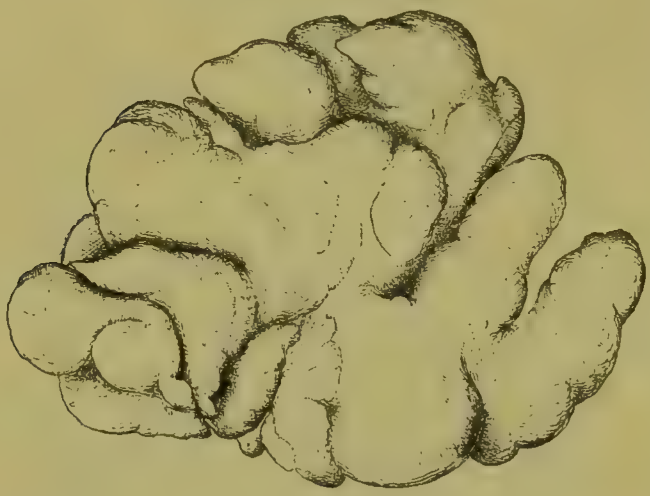
FIG. 51.—A fatty tumour, showing extreme lobulation.

Symptoms. — Fatty tumours are soft, and give to the fingers an indistinct feeling of fluctuation, so that they are liable to be mistaken for chronic abscesses. The most common situation for them to be found is over the shoulder, and they are believed to be caused in this situation by the irritation produced by the pressure of the braces or shoulder straps. They are distinctly circumscribed and generally lobulated. This lobulation is especially to be felt at the margin of the growth. If the tumour is pinched up between the forefinger and thumb so as to render the skin tense over it, it presents here and there little dimples where the capsule is attached to the skin. The growth is freely movable on the parts beneath. Lipomata are for the most part single, but cases are not uncommonly met with where they are multiple. The multiple lipomata are more frequently met with in the forearms than elsewhere. Sometimes the amount of fibrous tissue in lipomata is considerably in excess of what is found in normal adipose tissue. These tumours are called fibro-lipomata. They are much firmer and harder than the ordinary lipoma and often more extensively lobulated. They may also be pedunculated, and under these circumstances they show a tendency to slough from deficient supply of blood. A peculiarity about the lipomata is that they have a tendency to shift their position: this is probably merely the result of gravity; the tumours being loosely connected to surrounding structures have a tendency to sink simply on account of their own weight. As a rule they grow slowly and cause no pain. Sometimes, however, they grow rapidly and may attain an enormous size. Many years ago I removed after death a fatty tumour from the abdomen of a man, which weighed 29¾ lbs. and the circumference of which was 39½ inches.

The **diagnosis** of fatty tumours is generally easy. The only growths for which it may be mistaken are chronic abscess and sarcoma. It may be distinguished from chronic abscess by its margin, which is abrupt, rounded, and lobulated, whereas the margin of an abscess is shelving. If any doubt exists, the introduction of an exploring syringe at once establishes the diagnosis. From a sarcoma it may be distinguished by its rate of growth, which is slow, whereas in sarcoma it is rapid, and by the absence of any dimpling of the skin in the sarcomata.

Treatment.—The only treatment of a fatty tumour is removal, and it is desirable in most instances to advise this. Should, however, the patient be out of health or suffering from any organic disease, it is better to advise his bearing the slight inconvenience and annoyance of the tumour, which in all probability will never do him any harm, rather than run the risk which the operation under these circumstances might entail. The operation should be performed by making a free incision into the capsule and tearing the mass of fat from its bed; by this means the small vessels which supply the tumour will be torn and will bleed slightly, whereas if an attempt is made to dissect out the tumour, troublesome oozing will be the result. Care must be taken to remove all the lobules of the growth.

Parosteal lipoma.—Very rarely a lipomatous tumour may grow from bone, and is then termed a parosteal lipoma. When these tumours are deeply seated, beneath a mass of muscles and a dense fascia, their diagnosis is extremely difficult, and it is often impossible to ascertain their true nature until an exploratory incision has been made. As they are most likely, when fixed to bone, to be mistaken for sarcomatous tumours, such an exploratory incision should always be made in any case of suspected sarcoma of bone, in which there is any doubt of the diagnosis, before proceeding to amputate.

Diffused lipoma.—The diffused lipomata consist of ill-defined outgrowths of fat and cellular tissue, and occur principally in the nape of the neck or under the chin, and may attain enormous dimensions. They have no capsule, and it is impossible to isolate them in any way, as they appear gradually to merge into the surrounding subcutaneous fat. They usually occur in men between fifty and sixty years of age, and for the most part in those who have been in the habit of drinking large quantities of beer or spirits. They give no pain, nor do they cause any inconvenience, except from their size and the deformity they produce. As a rule no attempt should be made to remove these growths; it usually involves a very extensive proceeding in persons who are not good subjects for operation, and it is impossible to distinguish between the growth and the surrounding healthy fat. A very considerable reduction in these tumours is sometimes produced by a total abstinence from stimulants.

III. **Chondroma.**—The chondromata are tumours composed of hyaline cartilage. They occur most frequently in connection with one of the long bones, especially the metacarpal bones and phalanges of the hand, but also with other long bones, as the humerus, tibia, femur, and sometimes the ribs. They may spring either from the periosteum, which is the most common mode of origin when occurring in such bones as the humerus or femur; or from the medullary canal, which is usually the case when they grow from the bones of the hand. The former are termed *perichondroma*, the latter *enchondroma*. They may also grow from other parts, such as the parotid gland, the testicle, the breast, the thyroid body, or the subcutaneous tissue, but they are then usually associated with some other form of neoplasm, as sarcoma, adenoma or myxoma.

To the naked eye the chondromata present all the appearance of ordinary cartilage. They are often lobulated, being apparently made up of a number of bosses, and are inclosed in a fibrous envelope. Microscopically they are found to consist of cells, which are round, oval, or stellate, and are embedded in a hyaline matrix. Like the cells of normal cartilage they are contained in a capsule, and occasionally the processes of the stellate cells may be seen to communicate with each other in the matrix.

These tumours when growing from the bones of the hand are usually multiple (fig. 52), in fact it is rare to find only one bone affected; when they grow in other situations they are usually single. They occur for the most part in early life, and when consisting of cartilage alone, unmixed with other growths, are always benign and do not recur if removed. They are circumscribed, and often deeply lobulated. They are very hard, but not as hard as bone, yielding slightly on pressure, and by this character and also by their multiplicity, in some situations, they may be distinguished from osteomata. The chondromata may undergo various changes. When they grow from the epiphyses of the long bones, they almost immediately ossify, and they are then known as one form of exostosis, which will be presently described. They might with more propriety be termed ossifying perichondromata. Chondromata also undergo degenerative changes. They may undergo a mucoid softening in their centre, and the tissue breaks down into a fluid, so that they form a sort of cystic tumour, with walls of cartilage; to these the name of cystic chondroma used formerly to be given. They may also undergo calcification, and become converted into a calcareous mass without definite structure.

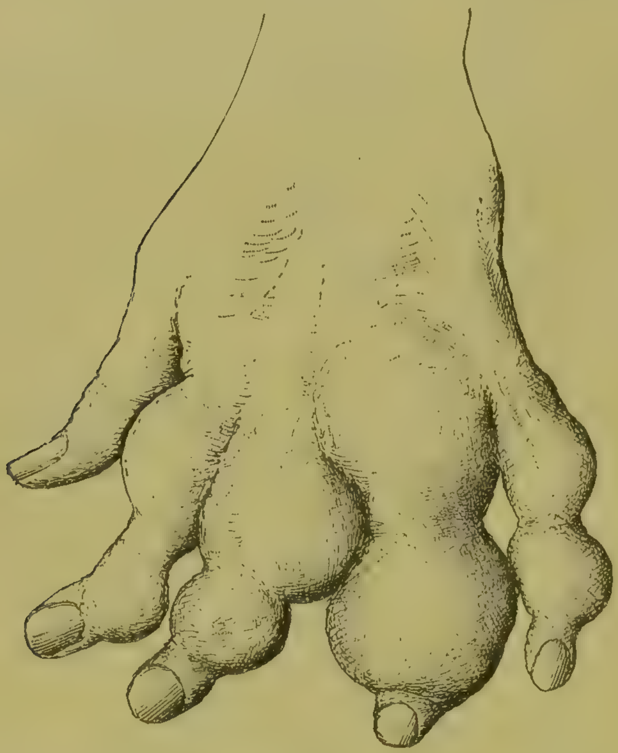
FIG. 52.—Chondromatous tumours of hand. (From a preparation in the Museum of St. George's Hospital.)

Treatment.—The treatment of a chondroma is removal when it is single. This can usually be easily accomplished by laying the capsule freely open and enucleating the tumour, and in this way even two or three of these tumours may be removed when they occur on the hand; but when the growths are very numerous, as was the case in the patient from whom fig. 52 was taken, amputation is the only resource available to free the patient of a useless and burdensome member.

IV. **Osteoma.**—Though bony tumours are not unknown in soft parts, as in ossified sarcomata or ossified muscle, the term osteoma or exostosis is confined to those bony tumours which grow from bone, and two forms only are properly spoken of as belonging to this class: (1) the cancellous or spongy exostosis, and (2) the ivory exostosis.

The **cancellous exostosis** is that form of tumour which has already been alluded to as an ossifying perichondroma. They are situated almost invariably in the neighbourhood of the epiphysial cartilage of a long bone, especially the lower end of the femur, the upper end of the humerus, and the terminal phalanx of the great toe. They consist of a mass of bony tissue, exactly resembling in structure ordinary cancellous bone, encapsuled by a thin stratum of hyaline cartilage, which ossifies as rapidly as it is formed. As this stratum ossifies on its inner surface, a fresh growth of cartilage takes place on its outer surface, and in this way the tumour increases. The process goes on until the epiphysis becomes joined to the shaft of the bone, and when the epiphysial cartilage disappears all further deposition of cartilage on the surface of the tumour ceases and its growth is arrested. In many instances a bursa is developed over the surface of the tumour, between it and the overlying skin, as the result of pressure.

These tumours grow slowly and cause no pain; so much is this the case that very frequently their presence is not discovered until they have attained some size, and then only by accident. They may be sessile or pedunculated.

The diagnosis of one of these tumours is remarkably easy, in fact they can scarcely be mistaken for anything else. An exceedingly hard tumour, distinctly circumscribed, growing slowly in the neighbourhood of an epiphysial cartilage of a long bone and firmly connected to the bone, can only be a cancellous exostosis.

Treatment.—As a rule these tumours are best left alone, and should not be interfered with unless they cause any inconvenience. As we have seen, they cease to grow when complete ossification of the bone from which they originate has taken place, and the patient can be confidently assured that this will be so. But in some cases they cause pain and inconvenience. For instance, when they grow from the inner side of the lower end of the femur—a favourite situation—they may interfere with the action of the inner hamstring muscles, and under these circumstances they should be removed.

Sub-ungual exostosis.—The exostosis which grows from the ungual phalanx of the great toe requires special mention. It is known as the *sub-ungual exostosis* and springs from the upper surface of the phalanx, and as it grows pushes the nail upwards and backwards. As it increases in size it projects beyond the nail and causes pain and inconvenience in walking. The treatment is removal, and this must be done very thoroughly, for if any trace of its cartilaginous envelope is left, the condition is sure to recur. It is advisable, therefore, to gouge away the surface of bone from which the tumour springs. Some surgeons recommend that the whole of the ungual phalanx should be removed, but this is not necessary.

Ivory exostosis.—The ivory exostosis grows generally from the membrane-formed bones, i.e. the bones of the skull and the lower jaw;

it also sometimes grows from other flat bones, the scapula and the innominate bone. It is exceedingly dense and hard, resembling the petrous portion of the temporal bone, and on section has the appearance of ivory. Microscopically it is found to consist of true bony structure, but the lamellæ are not disposed with the same regularity as in ordinary compact bone, and the Haversian canals are smaller and more numerous.

These tumours are rarely multiple, generally of small size, and do not produce any inconvenience except from pressure on important parts. They not infrequently grow from the roof of the orbit, and they may then displace the eye, stretch the optic nerve, and produce blindness. They may be at once recognised by their flattened, mushroom shape, their intense hardness, and their fixity to one of the flat bones. Frequently these tumours after attaining certain dimensions remain stationary and no further increase in size takes place. They have been known to necrose and exfoliate. As a rule no attempt should be made to get rid of them, for on account of their hardness this is often extremely difficult. When, however, they press on important parts, as the eye, removal should be attempted. Sometimes this may be effected by boring through the bone in every direction by means of a dental drill worked by electricity. By this means the connection of the tumour to the bone may be gradually ground away.

V. **Myxoma.**—Myxomatous tissue is a form of connective tissue, whose essential feature is the presence of a jelly-like material in a very delicate connective tissue stroma. The vitreous humour of the eye is the only place in the adult human body in which this gelatinous material is normally found. The myxomata resemble in appearance and structure this material, which is found in its typical form in the Whartonian jelly of the umbilical cord of the fœtus. They are not a large class of tumours, for many of the cases which were formerly regarded as myxomatous tumours are in reality other tumours which have undergone mucoid degeneration, as the chondromata, the adenomata, and the sarcomata. These are more properly known under the compound names of myxo-chondromata, myxo-adenomata, and myxo-sarcomata.

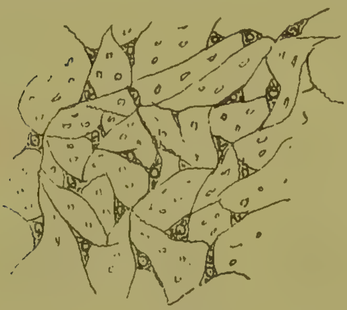

FIG. 53.—Myxomatous tumour. Diagrammatic.

The myxomatous tumours usually grow from the subcutaneous and submucous tissues, and frequently assume a polypoid form. Of these the ordinary gelatinous polypus of the nose is a typical example. The tumours are round, oval or lobulated masses, inclosed in a thin capsule of connective tissue. On section they present a gelatinous appearance of a pinkish colour, sometimes stained by extravasations of blood. Upon section a quantity of thick, glairy fluid exudes, which contains mucin. Upon microscopic examination the growth is found to consist of large stellate cells, giving off fine processes which freely communicate with the processes of other cells and thus form a very open network, in the interstices of which is contained the thick tenacious fluid which oozes away on section. Contained in this fluid are numerous small round cells, which are not in any way connected with the stellate cells (fig. 53). These tumours form soft, lobulated masses, which are frequently tense and elastic, and give to the fingers a sensation very like fluctuation, so that they are liable to be mistaken for cysts; or again they may be confounded with lipomata or soft fibromata. They are innocent tumours, and do not recur if completely removed. The only treatment consists in their removal, and this can generally be done without difficulty.

VI. **Glioma.**—Neuroglia is the name given to the delicate connective tissue of the brain and spinal cord, and tumours composed of this form of connective tissue and which occur only in the central nervous system are known by the name of *gliomata*. They are regarded by some as belonging to the class of embryonic connective tissue growths, and are grouped with the sarcomata, principally because a tumour very similar in structure, but which undoubtedly is a sarcoma, grows not infrequently from the sustentacular framework of the retina. This is known under the name of *retinal glioma*. But the true gliomata as they occur in the brain can scarcely be regarded as sarcomata, and really are more like an overgrowth of the connective tissue of the brain than distinct tumours, as they are never circumscribed and present the appearance and consistence of the brain substance. They are composed of round cells and an exceedingly delicate areolar stroma, the relative proportion of the two constituents varying in different tumours. The consistence of the tumours varies within certain limits according to the amount of stroma which they contain. As a rule these tumours are single, and do not give rise to secondary growths.

GROUP II. TUMOURS COMPOSED OF COMPLEX TISSUES

In the second group we include those tumours which resemble in structure the more complex tissues of the body, such as vessels, muscles, nerves, glands, &c.

These tumours include the following:

I. Vascular tissue (Angioma).
II. Lymphatic tissue (Lymphoma).
III. Muscular tissue (Myoma).
IV. Nervous tissue (Neuroma).
V. Papillary tissue (Papilloma).
VI. Glandular tissue (Adenoma).

I. **Angioma.**—The angioma or vascular tumours are composed of enlarged blood-vessels of new growth, and do not include those tumours which are produced by dilatation of already existing vessels. They will be considered with the other diseases of blood-vessels.

II. **Lymphoma.**—The lymphomatous tumours are growths exactly resembling in microscopical structure ordinary lymphoid structure. They come under the notice of the surgeon only as they occur in the lymphatic glands, and perhaps, strictly speaking, should not be classed as tumours, but rather as non-inflammatory hypertrophies. Their consideration will therefore be deferred until we speak of diseases of the lymphatic system.

III. **Myoma.**—The myomatous or muscular tumours, that is to say, tumours consisting of muscular tissue only, are exceedingly rare, but tumours consisting of muscular tissue in combination with fibrous tissue are very common; these tumours are known as the fibro-myomata. The tumours consisting of muscular tissue alone are divided, like muscular tissue itself, into two classes: (1) those composed of unstriped muscular tissue, the *leiomyomata*; and (2) those of striped muscular tissue, the *rhabdomyomata*. The **leiomyomata**, or tumours consisting of pure unstriped muscular tissue, have been recorded as occurring in connection with the muscular coat of the alimentary canal and the urinary passages; while **rhabdomyomata**, or tumours consisting of striped muscular tissue, have been described as growing in the neighbourhood of the kidney, as a congenital condition. The **fibro-myomata** are a large and important class of tumours, and occur especially in connection with the uterus and prostate. When occurring in the uterus they comprise that common group of tumours known as 'fibroids' of the uterus, and consist of smooth muscular fibre, intermingled with fibrous tissue. When occurring in the prostate they constitute the disease known as 'enlarged prostate,' and here the tumour or enlargement consists of an intermingling of plain muscular fibre, fibrous tissue, and glandular tissue, and is, properly speaking, a fibro-adenomyoma. It will be described with diseases of the urinary organs. With regard to the true myomata nothing can be said as regards their diagnosis, since they grow in connection with the internal organs, and, indeed, they can only be distinguished from the fibromata, after removal from the body, by microscopic examination.

IV. **Neuroma.**—Neuroma is a term applied to any tumour connected with or growing from a nerve trunk; but many of these tumours do not contain any nerve elements, and are simply other forms of tumour, such as fibromata, myxomata, or sarcomata, connected with a nerve. It is therefore desirable to divide the neuromata into two classes: (1) the *false neuromata*, to which class belong those tumours which, growing from a nerve, are nevertheless fibrous, mucous, or sarcomatous in their nature; and (2) the *true neuromata*, in which there is an actual growth of true nerve tissue.

True neuromata are almost always composed of medullated or white nerve fibre, though some few instances of neuromata composed of grey or non-medullated nerve-fibre have been recorded. They consist of bundles of medullated fibres rolled up and interlacing with each other in an intricate fashion so as to form a mass, which is held together by connective tissue, and in which ganglion cells are sometimes found. This mass is situated on a nerve, and is inseparably connected with it, though the fibres in the nerve are not as a rule directly continuous with the fibres coiled up in the mass. They may occur at any part of a nerve, are frequently multiple, and appear in many instances without any known injury to the nerve.

The true neuromata are generally found in the extremities. They are round or oval in form, and vary in size from a pin's head to an egg. The pain varies very considerably: in some there is no pain, though there is generally tenderness; in others the pain is very acute. In some it is dull and aching; in others, and more frequently, sharp and lancinating. It often radiates, gives rise to tinglings, 'pins and needles,' and formication in the parts to which the nerve is distributed, and is accompanied sometimes by muscular twitchings or epileptiform convulsions from irritation of motor fibres.

In the diagnosis, attention must be paid to the fact that tumours connected with nerves can readily be moved in a lateral direction, but scarcely, if at all, in the long axis of the nerve to which they are attached.

Frequently tumours appear on the stump of a divided nerve, and these are regarded by some as true neuromata. It seems, however, more correct to relegate them to a class by themselves, for they are not, on the one hand, false neuromata, for they undoubtedly contain nerve fibres, and still it is scarcely right to regard them as true neuromata, for though there are nerve fibres in them, they are very much smaller than normal ones, and are probably either the old fibres atrophied by pressure or young tubules which are not properly developed; and in addition to this there is a great excess of fibrous tissue. These growths may therefore properly be placed in a separate group and be termed **traumatic neuromata.**

In addition to these circumscribed nerve tumours, a form of neuroma has been described as **plexiform neuroma**, in which the terminal twigs of a nerve or division of a nerve become thickened and present a nodular appearance. These thickened fibres are bound together by areolar tissue, so as to form a diffused swelling. They are apt to arise in pigmented moles and are congenital in most cases.

Treatment.—It is desirable not to interfere with these tumours unless they cause pain, and then they must be excised. This should be done if possible without dividing the trunk; and in order to give the surgeon every facility for doing this, the limb, if the tumour is situated on one, should be rendered bloodless. By a careful dissection it can then be often enucleated without injury to the nerve. Should the nerve, however, require division, it should be at once sutured, and provision should be made before commencing the operation to transplant a portion of nerve from one of the lower animals in cases where it may be necessary to remove so large a portion of the nerve as to render suture of the ends impossible.

V. **Papilloma.**—The term papilloma is applied to those tumours which resemble in structure the ordinary papillæ of the skin or mucous surfaces. A papilla is a more or less conical mass, consisting of a capillary loop, inclosed in connective tissue, and coated by one or more layers of epithelium. And this is the structure of a papillomatous tumour, though the size varies considerably; an ordinary papilla of the skin is of microscopic size, a papillomatous tumour may attain large dimensions, and the blood-vessel, instead of being a single capillary loop, is often a vessel of considerable magnitude, which divides and subdivides into numberless branches, each of which terminates in a capillary loop, surrounded by one or more layers of epithelium, and so a structure is produced which may be aptly compared in appearance to a cauliflower. Sometimes these capillary loops become enormously elongated, and the tumour then resembles the villi of the chorion, consisting of a number of threadlike processes, each of which is composed of a capillary loop clothed by epithelium. The vessels in these tumours are usually of large size, and their coats are generally very thin, so that they bleed furiously if they are injured. The amount of connective tissue supporting the vessels varies considerably; in some it is very abundant, and is crowded with round cells and contains lymphatic spaces; in others, as in villous tumours, it is very scanty, and consists merely of a little tissue surrounding the capillary loop and supporting the epithelium. The cells covering the surface of the growth are of different kinds, and resemble the epithelium of the surface from which the tumour grows. When the tumour grows from the skin, the cells covering the surface of the growth resemble squamous epithelium; when it grows from the bladder, it is covered with transitional epithelium; and when from the rectum, with columnar epithelium.

The amount of epithelium varies. In warts there are many layers of stratified epithelium, which gives to the growth a hard, horny appearance; and in some cases the cells are pigmented, so as to give to the tumour a brown or black colour: in the rectum, on the other hand, the papillomata are covered with a single layer of cells and are very soft. The principal cause which gives rise to papillomata is irritation: thus they are common on the hands of children from the irritation of dirt; around the corona glandis of the penis, where the secretion of the glandulæ odoriferæ is retained in cases of phimosis, or about the vulva of the female from the irritation of leucorrhœa or gonorrhœa.

The principal forms of papilloma on the skin are warts and condylomata. On the mucous surfaces they occur most frequently in the larynx, rectum, and bladder. They will be described in their appropriate sections.

VI. **Adenoma.**—The adenomata or glandular tumours are those growths which in their minute structure resemble secreting glands, but they differ from them in being unable to produce the secretion of the gland they resemble.

They grow always from some form of secreting gland, as the breast, the prostate, the secreting glands of the intestine, &c. As there are two forms of secreting glands, the racemose and the tubular, so we find two forms of adenomatous tumour which are named respectively the *racemose* and the *tubular adenomata*, and their structure is that of epithelium, of the same character as that of the gland from which they grow, arranged either in acini or tubules, bound together by connective tissue. Very often the amount of connective tissue is out of all proportion to the epithelium; and then the term *fibro-adenoma* is applied to the growth; and again sometimes the epithelial spaces are greatly enlarged and distended with fluid, and then the term *cystic adenoma* is applied to them.

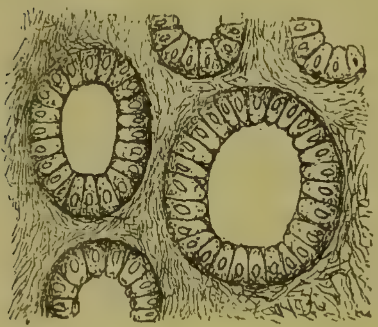
FIG. 54.—Racemose adenomatous tumour. Diagrammatic.

The **racemose adenomata** occur most frequently in the mammæ and prostate gland. They also occur in the parotid, but here they are generally associated with myxoma and chondroma. Cases have been recorded in which they have originated in the sebaceous glands of the skin, the glands of the soft palate, and other situations. They are composed of small sacs or spaces, irregular in shape, lined with epithelium and connected together by fibrous tissue (fig. 54).

The **tubular adenomata** are principally found in the intestinal canal, especially the rectum, and consist of tubules, resembling the crypts of Lieberkühn, lined by epithelium. They are often pedunculated.

The adenomata are tumours of early life. They do not recur if removed; do not infect neighbouring lymphatic glands; nor give rise to secondary deposits.

GROUP III. EMBRYONIC CONNECTIVE TISSUE TUMOURS

The tumours belonging to this group are composed of tissue resembling embryonic or immature connective tissue, in which cells of various shapes and sizes, but all belonging to the connective tissue type, form the greater part of the growth. They have been defined by Billroth as tumours 'consisting of tissue which belongs to the developmental series of connective tissues, and which do not, as a rule, go on to the formation of a finished type of tissue, but tends rather to peculiar degenerations of the developmental forms.' In other words, it may be said that these tumours consist of embryonic or immature connective tissue, which retains the structure of embryonic tissue throughout its life history; thus being unlike normal embryonic tissue, that in process of development becomes converted into fibrous tissue, cartilage, bone, &c. It is true that in parts, and sometimes in the major part of the growth, this tissue may undergo developmental processes, and become converted into structures of a higher grade, but this is not true of the *whole* growth; there are always some portions at the growing part of the tumour which retain their embryonic character throughout. The tumours of this group are all classed under the name *Sarcomata*, which has thus come to have a very definite meaning instead of being applied, as it formerly was, to any soft, fleshy growth.

The **sarcomata** consist of cells, embedded in an intercellular substance. The cells are masses of protoplasm, without any distinct wall, and contain one or more nuclei. They vary very much in shape and size, and it is for the most part upon the shape of the cells that division of the sarcomata into sub-groups is based. The cells may be round and small, no larger than leucocytes, or they may be three or four times this size; or they may be fusiform or spindle-shaped, and vary greatly in size in different tumours; so that growths composed of these spindle-shaped cells are often further divided into small and large spindle-celled sarcomata; finally, the cells may be large plaques, which are granular, flattened, and contain from ten to forty or more nuclei. They have been likened to the cells which occur in the marrow of fœtal bones, and are therefore termed myeloid cells. The intercellular substance varies also: it may be fibrous or homogeneous, that is to say, there may be no definite stroma; it may be abundant or scanty. But wherever it can be recognised it always possesses this important characteristic, that it penetrates between the individual cells, so that it is uniformly distributed throughout the tumour. This constitutes an important anatomical distinction between the sarcomata and the carcinomata, for in these latter tumours the cells are arranged in definite alveoli, with no stroma whatever between the individual cells. There is one division of the sarcomata, in which this distinction is not quite so clear, because the cells in this group are contained in separate alveoli, and this has earned for them the name of *alveolar sarcomata*; but even in these tumours, fine fibrous filaments may be observed coursing between the individual cells, in addition to the fibrous tissue forming the walls of the alveoli, and this is never the case in carcinomata.

The arrangement of the vessels in these two classes of tumours is different, and affords another characteristic difference. In the sarcomata, which are very vascular, the vessels are often merely intercellular channels, that is to say, passages the walls of which are formed by the cells of the growth, or, if true vessels are present, their coats are exceedingly thin and liable to be ruptured. Hence, extravasations of blood are of very common occurrence in sarcomatous tumours. In the carcinomata, on the other hand, the vessels ramify in the stroma of the tumour, and never course between the cells. No lymphatics have ever been found in the sarcomatous tumours, and dissemination does not take place, as a rule, by them—though to this there are many exceptions but by the blood-vessels ; this may probably be, at all events in part, due to the close relationship of the vessels to the cells.

The sarcomata may, and frequently do, undergo developmental changes. The most elementary and simplest form of sarcoma is the small round-celled, with a scanty homogeneous matrix. This form exactly resembles ordinary granulation tissue, and can scarcely be distinguished from it. And as in granulation tissue the round cells, in their process of development into fibrous tissue, first become elongated and spindle-shaped, so in sarcomatous tumours the round cells may become elongated and the spindle-celled sarcoma is formed. Then a further developmental change may take place and fibrification may ensue, and the greater part but not the whole of the sarcomatous tissue may become converted into fibrous tissue, for at the growing margin of the tumour a certain amount of sarcomatous tissue will always be discoverable. Again, in other cases, the new growth becomes converted into other forms of connective tissue, cartilage, and bone. These tumours were formerly known as fibro-sarcoma, chondro-sarcoma, and osteo-sarcoma, but it is more correct to speak of them as fibrifying, chondrifying, or ossifying sarcomata. The fibrous transformation most frequently occurs in sarcomata of the subcutaneous tissue, or the fasciæ or intermuscular planes ; the cartilaginous in sarcoma of the testicle ; and the bony in those of the bones.

Sarcomata are also very liable to undergo degenerative changes. They may undergo fatty degeneration, but the change is not generally sufficient to obscure the true nature of the tumour ; or they may undergo calcareous degeneration, which may involve the greater part of the tumour, and completely destroy its original structure. They are very liable to undergo mucoid softening in their centre, and form a cavity which constitutes one form of the so-called cystic sarcoma. When by reason of their growth they reach the surface of the body, the skin over them gives way, and they form a large fungating, sprouting mass, which bleeds freely and is known by the name of fungus hæmatodes. Cysts are often contained in sarcomatous tumours. These, as just mentioned, may be the result of mucoid degeneration in their centre, or from the mixture of gland tissue with them, for they are often found in such organs as the breast and testicle.

The naked-eye appearances of sarcomatous tumours vary considerably, but for the most part present a grey or brownish-grey succulent, semi-translucent appearance, not unlike size ; on section they frequently present patches of extravasated blood, both recent and old. Many of them are encapsuled and appear to be completely isolated ; others are circumscribed, but have no capsule ; and again others scarcely form definite tumours, but present the appearance of infiltrating masses.

The clinical characters of the sarcomata vary so much that it is impossible to give any general account of their symptoms and course. They may grow in any part of the body ; in both sexes ; and individuals of all ages are liable to them. They are, however, essentially a disease of early life, and are the usual form of malignant disease met with in childhood ; the carcinomata scarcely ever appearing in early life. All sarcomata must be regarded as malignant, but the degree of malignancy varies within extreme limits, from the melanotic sarcoma, which may be regarded as the most malignant of all tumours, to the myeloid sarcoma of bone, which can scarcely be regarded as a malignant tumour. The degree of malignancy depends to a great extent on the structure of the individual sarcoma and its origin; and it may be laid down as a broad rule that the nearer a sarcoma approaches in structure to fully formed connective tissue, the less malignant will it be. Most sarcomata grow rapidly, but this rule has exceptions, some of the tumours increase in size slowly. With regard to their consistence they may vary within the widest limits, from a semi-fluid growth to one having the consistency of cartilage or bone. They may be distinctly circumscribed or they may be diffuse, so that it is impossible to limit them and to exactly define the spot where the healthy structure ceases and the morbid growth begins, for it must be distinctly understood that the sarcomata are infiltrating growths, and even in those cases where they appear to be circumscribed and distinctly limited, the tissues around are deeply involved in the disease. Some of the sarcomata, especially some of those growing from bone, are so vascular that the tumour pulsates expansively, and on auscultation a loud bruit may be heard.

Varieties.—The shape of the cells in sarcomatous tumours naturally divides them into three divisions: (α) the round-celled; (β) the spindle-celled: and (γ) the myeloid-celled; but in addition to these there are certain other varieties of sarcomata which will have to be described after these main divisions have been considered.

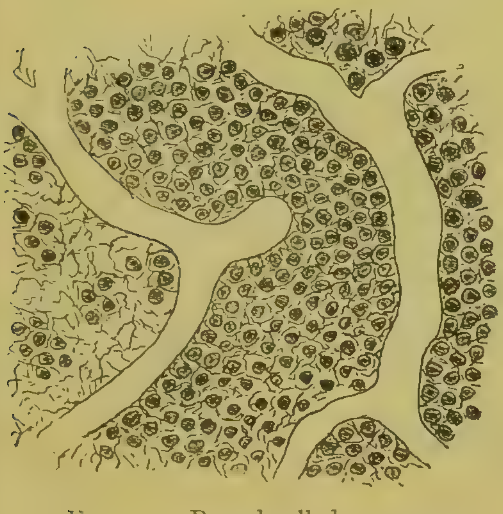

FIG. 55.—Round-celled sarcoma. Diagrammatic.

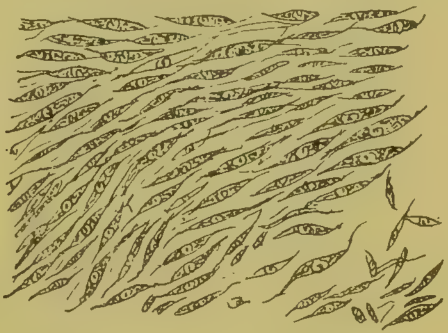

FIG. 56.—Spindle-celled sarcoma. Diagrammatic.

α. The **round-celled sarcoma** (fig. 55).—The round-celled sarcomata may grow from any part of the body where there is connective tissue, but occur principally in the skin and subcutaneous tissues, in the bones and periosteum, the glands and viscera. They consist of round cells; in some tumours small and resembling leucocytes; in others of larger size; embedded in a small amount of homogeneous or fibrillated intercellular substance. They are soft, pulpy, whitish or grey, and were formerly known by the name of encephaloid cancer. They are very vascular and often present patches of extravasation where vessels have given way. They grow very rapidly, often attain a large size, and become disseminated in the internal organs. The lymphatic glands are also frequently affected. Their malignancy is of a most pronounced type.

β. The **spindle-celled sarcoma** (fig. 56).—The spindle-celled sarcomata are found in connection with the skin and subcutaneous tissue, or growing from fasciæ, especially the deeper layers of the periosteum of long bones and the bones of the face. They also occur in the breast, testicle, and eye.

They consist of elongated, oat- or spindle-shaped cells, united by a scanty homogeneous or fibrillated matrix, or without any intercellular substance, the cells lying in close apposition and often arranged in trabeculæ, so as to give them the appearance of a fibroma, for which they may be mistaken. The cells vary in size in different tumours, but are pretty constant in size in any given growth. This has led to the division of this group of sarcomata into two subdivisions, the *small* and *large* spindle-celled sarcoma. In the former of these the cells may not be longer than the diameter of a leucocyte, and these tumours are usually firm and of a pinkish yellow colour. They grow by preference from fibrous structures, as the skin and fasciæ. Clinically their great characteristic is their tendency to local recurrence after removal, without giving rise to dissemination in internal organs. Some years ago a patient was admitted into St. George's Hospital who had had a tumour of this kind removed from his arm twenty times, and eventually underwent amputation at the shoulder joint, but there was no evidence of any disease elsewhere, though recurrence had taken place in the stump. From this marked characteristic, Paget described these tumours as *recurrent fibroid.*

In the *large spindle-celled* sarcoma the cells are some five or six times as large as in the other variety. They are of a pinkish white colour, of soft consistence and very vascular, and are frequently the seat of extravasations. They often grow from the periosteum of the shafts of the long bones, and were formerly known as encephaloid cancer of bone. They differ in their clinical characteristics from the small spindle-celled sarcomata, inasmuch as they are very malignant and rapidly prove fatal from secondary internal growths. After removal their tendency to recurrence is very great, even when the parts removed have been widely distant from the seat of disease. For instance, in a case of this disease affecting the lower end of the femur, amputation was performed at the hip joint, and recurrence took place in the stump in six weeks.

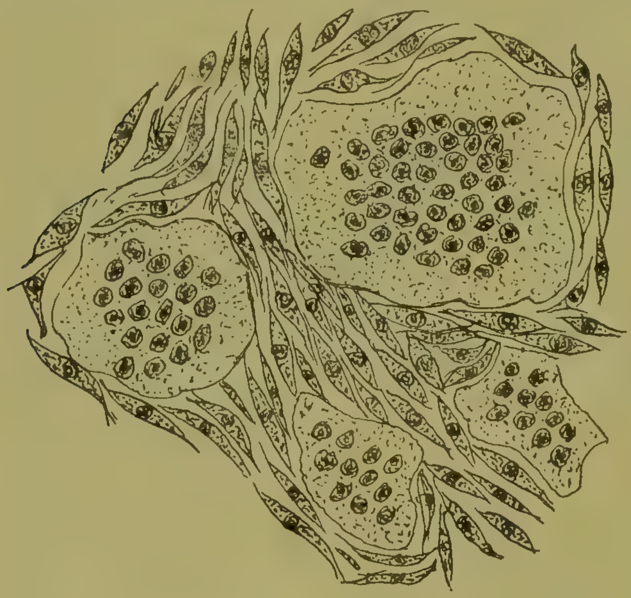

FIG. 57.—Myeloid sarcoma. Diagrammatic.

γ. The **myeloid-celled sarcoma** (fig. 57).—The myeloid sarcomata grow almost exclusively from the interior of bones, and affect particularly the lower end of the femur, the upper end of the tibia, and the bones of the jaw. As they grow they absorb the bone, but as they do so a fresh deposit of bone takes place from the periosteum, so that the bone becomes enlarged. Absorption, however, takes place more rapidly than deposition, and thus the tumour becomes inclosed at last in a thin shell of bone, which on pressure yields a peculiar sensation which is known as 'egg-shell crackling.' This may finally be perforated, and the tumour invades the surrounding soft parts. Microscopically these tumours are found to consist of round and spindle-shaped cells such as are present in other sarcomata, but in addition to these there are the characteristic myeloid cells—large, multi-nucleated masses of protoplasm—which resemble those which occur in the marrow of fœtal bones. The appearance under the microscope is that of large myeloid cells embedded in a matrix of round and spindle-shaped cells. The nuclei in the cells vary from ten to forty or more in number: they are oval in shape, and have a distinct and highly refracting nucleolus.

Myeloid tumours are usually firm and fleshy in consistence, but sometimes soft and jelly like. On section they present a deep red or maroon colour, not unlike the muscular structure of the heart, but blotched with bright patches of crimson or dark purplish brown, the result of recent or old extravasations of blood. They frequently contain cysts, often of considerable size. They are the most innocent of all the sarcomatous tumours, and show very little tendency to recur if thoroughly removed.

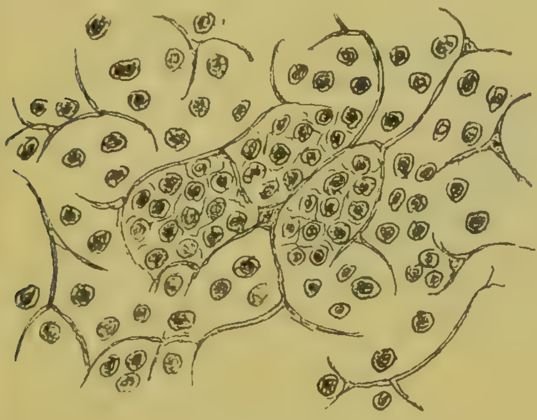

FIG. 58.—Lympho-sarcoma. Diagrammatic.

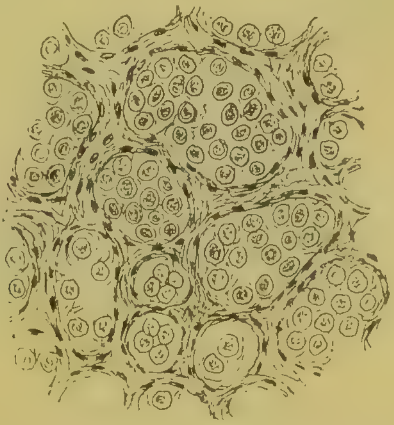

FIG. 59.—Alveolar sarcoma. Diagrammatic.

Besides these typical varieties of sarcomatous tumours there are some other forms which require a passing notice. These are:

1. The mixed celled sarcoma.
2. The lympho-sarcoma.
3. The alveolar sarcoma.
4. The melanotic sarcoma.
5. The psammoma.
6. The plexiform sarcoma or cylindroma.
7. Sarcomatous blood cysts.

1. The **mixed celled sarcoma** occurs more often in connection with the bones than elsewhere. It consists of a mixture of both spindle-shaped and round cells, and cannot anatomically be included in either of the first two divisions of sarcoma. It is not possible to distinguish it without a microscopical examination.

2. The **lympho-sarcoma** (fig. 58) grows in the lymphatic glands, mucous membranes, tonsils, and testicles. It consists of a reticulum exactly resembling the reticulum of lymphoid tissue, in which are contained the sarcoma cells which resemble in size and appearance the leucocytes of the blood.

3. The **alveolar sarcoma** (fig. 59) has already been alluded to as differing from the other sarcomata in the fact that the cells are contained in definite alveoli, formed by bundles of connective tissue. In this respect they therefore resemble the carcinomata, as well as in the fact that the cells are large and resemble epithelial cells in appearance. But they may be distinguished from the carcinomata by the fact that delicate fibrillæ may be distinguished within the alveoli, between the individual cells, which can never be done in the other class of tumours, and also by the difference in origin and the fact that portions of the same tumour may be found to consist of true sarcomatous tissue. They most commonly grow from the cutis, and more especially in connection with pre-existing hairy moles, but they have been described also as growing from bone.

4. The **melanotic sarcomata** form an interesting group of sarcomatous tumours which possess certain important characteristics. They grow only from structures containing pigment, such as the choroid coat of the eye and the skin. They often in the latter situation originate in a mole. They are usually found in connection with the spindle-celled variety of sarcoma (fig. 60), but may also occur in connection with the round-celled. They simply consist of one or other of these forms of sarcomatous tumour with the addition that the cells contain a large quantity of dark-coloured pigment granules, which gives to the tumour a dark brown or black colour. The pigment is present only in some of the cells of the tumour, the rest remaining colourless, and the pigmented cells usually, for the most part, occupy the periphery of the tumour. The cells are usually of large size, and the intercellular substance between them is scanty and contains pigment. The tumours are circumscribed, round or oval in shape, soft and pulpy, and of a dark brown or black colour (fig. 61). They differ from most other sarcomata in disseminating themselves along the lymphatic vessels, so that early in the disease the lymphatic glands become involved, and frequently little black nodules may be seen growing from the skin in the course of the lymphatic vessels, where secondary growths have sprung from them. These tumours are perhaps the most malignant of all malignant tumours, and very rapidly cause secondary growths in the internal organs, but at the same time they are not so prone to return locally after removal as many other forms of malignant tumours.

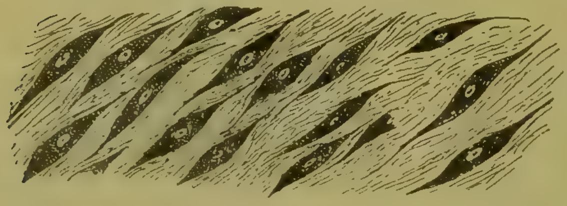
FIG. 60.—Melanotic sarcoma. Diagrammatic.

5. The **psammoma** is a very rare form of sarcoma, which occurs only in connection with the vessels of the brain. The tumour consists of round cells, among which are small concentric calcareous globules, which resemble the 'brain sand' found in the pineal gland. They possess no clinical features of any interest, and rarely give rise to any symptoms.

6. The **cylindroma** or **plexiform sarcoma** is a peculiar form of tumour, the exact mode of origin of which is a matter of considerable doubt. It is met with in the brain, the orbit, the salivary glands, and other situations, and is soft and gelatinous in consistence. Its great peculiarity consists in its minute structure. Under the microscope it is found to consist of cylinders arranged in a plexiform manner and connected together by delicate connective tissue. The cylinders are composed of polygonal

cells closely massed together, without any intervening intercellular substance. These tumours are probably round-celled sarcomas, which have undergone hyaline or mucoid degeneration. In confirmation of this view it may be stated that cases have been recorded where these tumours have been removed and have recurred, and the secondary growths have presented the ordinary characters of round-celled sarcomata.

7. **Sarcomatous blood cysts.**—Soft sarcomatous tumours, on account of their great vascularity, sometimes become converted into blood cysts. This arises from extravasation of blood into the substance of the tumour, which expands it so as to form a cyst filled with blood, the wall of which consists of a thin layer of sarcomatous tissue, which usually can only be distinguished by microscopic examination.

Diagnosis.—The diagnosis of sarcoma is often a matter of considerable difficulty. The rate of growth is a point which often serves to distinguish it from innocent tumours. The unequal consistence of the tumour, which is a marked feature of these growths, is also an important point to bear in mind, and the part in which the tumour takes its origin is of assistance in coming to a right conclusion. The diagnosis from carcinoma is especially difficult, but is not a matter of much importance, as the treatment of the two is the same. Frequently the only indications to guide us are the seat of the disease and the patient's age. The absence of any implication of the lymphatic glands would point to sarcoma. The diagnosis can always be verified after removal by microscopic examination.

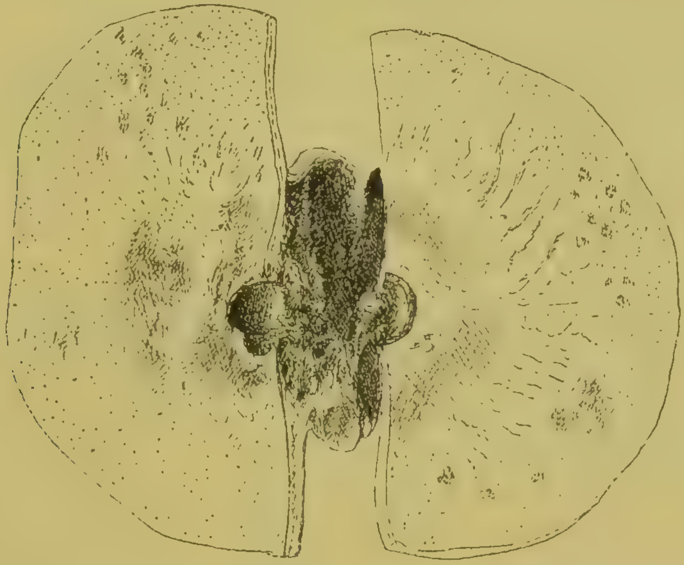

Fig. 61.—Melanotic sarcoma.
(From a preparation in the Museum of St. George's Hospital.)

The **prognosis** of sarcoma varies with the nature of the growth, and the seat of the disease. It must be borne in mind that all sarcomata, if not treated, will terminate fatally, unless the patient is carried off previously by some intercurrent disease, but the period at which death will ensue is very variable. Some forms of sarcomata, as the melanotic, or the spindle-celled when it attacks the periosteum, or the round-celled of the testicle, are most rapid in their course, and even after removal almost certainly recur or produce secondary growths and kill the patient; whereas the myeloid sarcomata have been known to exist for years without destroying life, and after thorough removal have little tendency to recur. In a case of myeloid tumour of the femur, for which I amputated the thigh twenty-one years ago, the patient is still alive, and has no recurrence.

Treatment.—The treatment of sarcoma is removal, and the chief point to insist upon is that the removal should include a considerable area of surrounding tissue, however healthy it may appear. Thus in a sarcoma of the breast, the whole organ should be removed; in sarcoma of a bone, if it occurs in one of the extremities, the limb should be amputated; if it is a myeloid tumour, the amputation may be performed just above the growth; if, on the other hand, it is a periosteal sarcoma, the whole bone from which the tumour grows should be removed.

It must sometimes happen that cases of malignant disease will present themselves to the surgeon which have passed the stage in which they are capable of being removed by operation, and until quite recent days these cases have been abandoned as hopeless. Within the last few years, however, the treatment of sarcomata by the subcutaneous injection of what is known as Coley's fluid, has raised a hope that something may be done for these desperate cases. This fluid consists of a mixture of the products of the growth of the streptococcus of erysipelas and the bacillus prodigiosus, sterilised by heat. It has long been known that malignant growths occasionally disappear with great rapidity after an attack of erysipelas; and when Fehleisen was investigating the etiology of erysipelas he took advantage of this circumstance to prove experimentally that the microbe which he had isolated and cultivated was the true infecting virus of this disease; for he injected some of his pure cultures into patients suffering from hopeless malignant disease, primarily with the object of proving the true infecting nature of the microbe, but secondarily with the hope of alleviating the condition. Other investigators, among whom was Coley, followed, but it was soon found that an attack of erysipelas could not by this means be obtained with any certainty, and the next step was to employ the toxine produced by the streptococcus of erysipelas without the living organism. This was done by separating the toxines by filtration, and sterilising with steam. By this means greater certainty was produced, and the dose could be regulated, the effect being proportional to the amount inoculated, and therefore the danger was diminished. The effect produced, however, by the injection of toxine was not so great as when the living cultures were used, and therefore, in order to increase its effects, Coley mixed with it the toxine of the bacillus prodigiosus, a non-pathogenic organism, which has the power of intensifying the action of the streptococcus of erysipelas, as well as many other pathogenic organisms.

The result of this injection when successful is to produce a very serious reaction; there is usually a rigor, with marked rise in the temperature, vomiting, headache and often diarrhœa, and the tumour begins to disappear, by a rapid form of degeneration, which has been compared to the degeneration of the hepatic cells, which takes place in acute yellow atrophy of the liver. Coley recommends that the injections should be commenced with a very small dose, half a minim, and gradually increased until the reaction temperature reaches 103° F. to 104° F. They may be given daily when the reaction is slight, but less frequently when it is severe. It must be admitted that the plan of treatment is one of considerable danger, and it is not justifiable to use it except in cases which are otherwise hopeless. The principal dangers are from collapse and pyæmia; the latter is to be feared when there is a suppurating and sloughing sore, because the pyogenic organisms present in the wound are rendered more virulent by being associated with the toxines of other organisms. Coley states that this plan of treatment has proved most successful in the spindle-celled sarcomata, and that the benefit obtained in the round-celled sarcomata is not so great. Our knowledge of the results of this treatment is still in its infancy, and it is perhaps too early to express an opinion. As far as my own personal experience goes, I must confess that I am very sceptical as to its use. A considerable number of cases have been recorded in which this treatment has been adopted for supposed sarcomatous tumours, and has been followed by their disappearance; but, as far as I am aware, in only one case in this country has a tumour been dispersed by Coley's fluid, which has been proved to be sarcoma, by removal of portions and microscopic examination.[1] As, however, the disease is in itself necessarily fatal, it would appear to be perfectly justifiable to resort to it, even though it entails a considerable risk to the life of the patient. The treatment should be continued until the whole of the tumour has disappeared, or until it has become so small that, in order to expedite matters, it can be removed.

GROUP IV. TUMOURS COMPOSED OF CELLS OF AN EPITHELIAL TYPE

There is only one class of tumours in this group, the Carcinomata or Cancers, and clinically speaking these tumours are all malignant.

Carcinoma is anatomically defined as a tumour which is composed of a stroma of fibrous tissue, presenting an alveolar structure, within the alveoli of which are contained collections of cells resembling those of epithelium. These cells are derived from pre-existing epithelium, and therefore carcinomata can only take their origin primarily from those places where epithelium is naturally present, that is the cutaneous and mucous surfaces, including the involutions formed in ducts, follicles, &c., of glandular structures. The cells always resemble the epithelium from which they are derived, and this naturally divides the carcinomata into groups, according as the cells are spheroidal, squamous, or columnar. The cells are not embedded in a matrix, like the cells of sarcoma, but lie closely packed within the alveoli, and have no organic connection with the fibrous stroma. Unlike the cells of sarcoma, they show no tendency to undergo developmental processes and pass into a higher stage of organisation: but they have, on the other hand, a marked tendency to undergo fatty degeneration, and are often found to be crowded with fat molecules. The stroma consists of a network of fibrous tissue, in which may be seen connective tissue cells, and in which are contained the blood-vessels which supply the tumour (fig. 62).

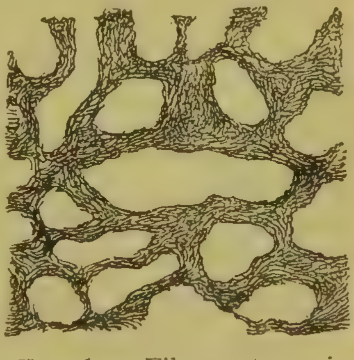

FIG. 62.—Fibrous stroma in scirrhus cancer. Diagrammatic.

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[1] Mr. Battle's case, *Med. Soc. Trans.* 1898.

In order to study the origin of cancer, let us take a single alveolus of a gland, such as the breast, which consists of a membrana propria lined with a single layer of epithelium. This epithelium increases and distends the alveolus, which enlarges and forms a closely packed cylinder, or column of cells, which invades the neighbouring tissues. As it does this the process or invading column becomes surrounded by a number of small round cells, which infiltrate the tissues. These are probably, at all events in the first instance, migrated leucocytes, and under their phagocytic action the original structure disappears, and in its place a new connective tissue is formed, most likely from cells formed by a proliferation of the connective tissue cells of the part, as in the formation of ordinary scar tissue (see p. 17). This new connective tissue incloses the invading columns, and forms the stroma of the neoplasm ; so that in this way we have formed the essential structure of carcinoma (fig. 62)—a fibrous stroma forming loculi or spaces in which are contained epithelial cells, formed from pre-existing epithelium and being in fact greatly enlarged alveoli or ducts of secreting structures, with the walls of the alveoli formed of new tissue, and not, as was formerly supposed, of the remains of the old connective tissue of the part. It will be seen, therefore, that cancers are not encapsuled, but infiltrate surrounding tissues and pass beyond the structures in which they originate, and these structures around the tumour, which very often appear to the naked eye to be natural, are already infiltrated with these advancing columns of epithelium. The column of cells, after the wall of the alveolus in which they were originally contained has been destroyed by the round cells, probably advance along the lymphatic spaces and vessels, and this may account for the early date at which the cancer, after its formation, invades the lymphatic glands. The glands first affected are the nearest set of glands receiving the lymphatics from the affected part, and these in some forms of cancer are very early enlarged, and for a time the enlargement seems to be confined to this set of glands, but presently glands more remote become affected, or the disease appears in other parts of the body.

One of the most marked characteristics of cancer is its tendency to reproduce itself in distant parts, or, in other words, to form secondary growths. The manner in which this is brought about has been the subject of much controversy, but it is now pretty generally believed that it is by what is known as the 'implantation theory.' This is, that some of the cells of the cancer become detached and find their way either into the lymphatic- or blood-vessels and by them are carried to distant parts, where they form minute emboli which become lodged in some suitable situation, and acting as grafts take root, grow and multiply and produce a secondary tumour, which is identical in structure with that from which it sprang. Thus, for instance, in a secondary tumour in the shaft of a long bone, the result of a carcinoma of the breast, we should find the spheroidal cells which are the characteristic of this form of cancer ; or, again, if the tumour were the result of rectal cancer, we should find the columnar cells of this form of the disease.

A marked feature of carcinomata is their great tendency to undergo degenerative changes. This in the first instance consists in a fatty change and commences in the centre of the growth, that part which is the oldest and farthest removed from the normal blood supply. Little dots of a yellowish colour and cheesy consistence appear on the surface of a section of the tumour, which are visible to the naked eye. If a microscopic examination is made, the cells will be found to contain and be obscured by fat molecules, and where the degeneration is more advanced the cells have disappeared and only granular débris remains.

As the tumour grows it makes its way to the surface, and infiltrating the skin for a considerable distance around, it ulcerates and forms an indolent ulcer, with hard, elevated edges. This ulcer is very prone to bleed, and discharges an offensive ichorous fluid, which tends to undermine the patient's strength and cause death from exhaustion. Cancerous tumours, therefore, may be said to degenerate and soften in their centre and to ulcerate on their surface.

Causes.—With regard to the causes of carcinoma very little is known. There does not appear to be any constitutional condition, such as one recognises in tuberculosis, which is characteristic of this disease. Patients who are attacked by cancer may be apparently in a condition of robust health, but, on the other hand, are frequently weak, anæmic, and worn out. Even the hereditary nature of the disease is by no means certain. Formerly great stress was laid on this, and the hereditary tendency was always looked upon as an essential feature in the diagnosis; but many observers in the present day are inclined to believe that the heredity of cancer is by no means proved, and when we consider the wide-spread diffusion of the disease, it is no matter of wonder that in a vast number of family histories which we investigate we should find some traces of cancer having affected some members of the family. There is, however, no doubt that age has an important influence on the occurrence of cancer. It is a disease which is rarely seen before the age of 20, and from this age it increases in frequency, being comparatively uncommon during the first decade, and then increasing up to the age of 45 to 50. After this age the number of deaths from cancer begins to decline, but the proportion of deaths from cancer of those living over the age of 50 continues to increase, according to Walshe, up to the age of 80. The sex has also some influence on the occurrence of cancer; it is more common in the female than in the male: this is on account of the fact that cancer so frequently attacks the two organs special to the female generative system, the breast and the uterus.

Locality is believed by some to have an influence on the occurrence of this disease. Certain districts, especially low-lying ones, near rivers, which are liable to floods, and even certain houses, have been described as being situations in which cancer is prone to occur. The fact that houses have been known to be occupied by people, often of different families, who have one after another become victims of cancer, raises the question whether the disease is contagious or not. Up to recent times, it has been believed that it certainly is not.

One other point requires mention in connection with the predisposing causes of cancer, and that is the fact that there can be little doubt from the statistics of the Registrar-General that cancer is largely on the increase in this country. According to Spencer Wells, the number of deaths from cancer in 1887 was nearly double what it was in 1861. Some have attempted to explain this by the greater accuracy of diagnosis in the present day, and by the fact that the deaths fifteen or twenty years ago from sarcoma were recorded as cancer, but this would scarcely explain the great difference in the figures.

As regards the exciting cause of cancer, our knowledge is scarcely more definite than in regard to the predisposing causes, but there is a growing tendency on the part of those who have especially worked at this subject, and are therefore best qualified to give an opinion, that the disease depends upon a micro-parasite, though this organism has never been distinctly proved to exist and to cause the disease. It is believed that if there is such a parasite, it probably belongs to a class of the fungi, the blastomycetæ. But this we can say with regard to the exciting cause of cancer, that in a very large number of cases there is the history of some injury, as a blow, or some long-continued irritation. It is a matter of everyday experience to meet with examples of this; where a scirrhus of the breast is attributed by the sufferer to a blow; or where a cancer of the tongue has been set up from the irritation of a jagged stump of a tooth; or an epithelioma of the lip from the constant contact of a pipe; or cancer of the scrotum from the irritation of soot in its rugæ in chimney-sweeps, or of the penis from the collection of secretion beneath the prepuce in a case of phimosis.

Varieties of Carcinoma.—As we have before stated, the forms into which carcinoma is divided are in accordance with the shapes of the epithelial cells from which they grow. Thus we have (1) the spheroidal-celled carcinoma, (2) the columnar-celled carcinoma, and (3) the squamous-celled carcinoma.

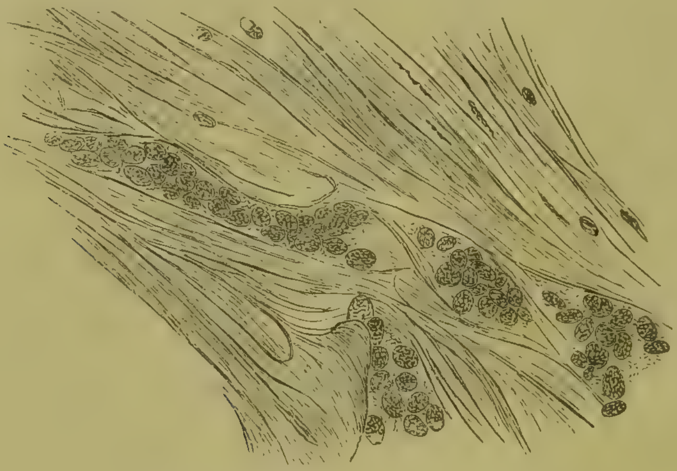

Fig. 63.—Scirrhus cancer.
(From 'A System of Surgery,' by Holmes and Hulke.)

I. **Spheroidal-celled carcinoma or glandular carcinoma** (figs. 63 and 64) is that form of carcinoma which arises in those parts in which spheroidal or glandular epithelium is normally present, and two chief varieties are met with: (α) the hard spheroidal-celled or scirrhus, and (β) the soft spheroidal-celled or encephaloid, but the difference between the two simply consists in the relative proportion of the cells to the stroma. In the scirrhus the amount of stroma is considerable, and the cells few in number and usually small in size, whereas in the encephaloid the stroma is small in proportion to the number of cells, which are of larger size and more rounded form. It is scarcely necessary, therefore, to make a division between these two forms except for convenience of description, and in many instances it is impossible to decide whether a given tumour belongs to the one or the other class. Moreover, the intimate relationship between the two is evidenced by the fact that the hard form, if it recurs after removal or if it appears as a secondary growth in some distant part, may do so as the soft variety.

a. The **scirrhus** or **hard spheroidal-celled carcinoma** is one of the most common forms of cancer, but nevertheless occurs in very few situations in the human body. It is principally found in the breast; in the alimentary canal, especially at the pyloric end of the stomach; in the pancreas, prostate, and the skin. It is characterised by its great hardness, feeling like a craggy stony mass, which has earned for it its popular name of 'stone cancer.' It grows slowly and never attains a very large size. As it occurs in the breast it forms an irregular nodulated mass, continuous with the gland and moving with it. As it grows the structure already formed has a tendency to contract and draw in the surrounding tissues by claw-shaped processes which extend from it in all directions; those which pass outwards to the skin pull it in, and produce the dimpling which is one of the characteristic signs of the disease. This peculiar property of contraction, which is such a marked feature in these tumours, is believed to be due to the newly formed fibrous tissue, which, like ordinary scar tissue, undergoes contraction after its formation. Sometimes it happens that from this cause the tumour diminishes in size and shrinks to such an extent that there may be scarcely anything left but a dense cicatricial-looking mass. As the growth reaches the surface, the skin becomes adherent to it; this becomes livid red and finally ulcerates. These tumours are often at first quite painless, at other times sharp lancinating pain is complained of, but after the skin becomes involved they are usually very painful.

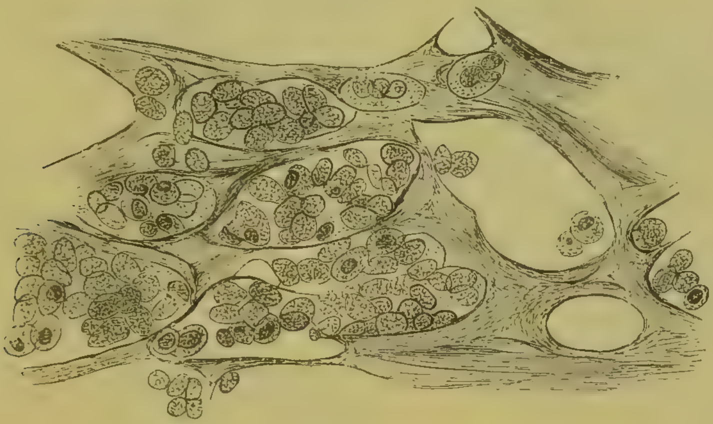

FIG. 64.—Scirrhus cancer.
(From 'A System of Surgery,' by Holmes and Hulke.)

When a section is made of a scirrhus tumour, it will be found to cut with a characteristic hardness and 'creaks under the knife.' Its cut surface is yellowish white, not unlike a raw turnip, and is streaked with white glistening bands of fibrous tissue sufficiently dense to be seen with the naked eye, and dotted over with minute yellow points where fatty degeneration has taken place. A peculiarity about the cut surface of a scirrhus tumour is that it often presents a cup-shaped or concave surface. There is no definite margin to the tumour, but the morbid growth gradually merges into the healthy normal tissue. Examined microscopically it is found to possess the character of a carcinoma: a fibrous stroma with spheroidal cells in its alveoli. But in the hardest tumours sections cut from the centre of the growth appear to consist almost entirely of fibrous tissue, for the cells are degenerated and obliterated by the shrinking; but at the periphery the characteristic structure is seen.

Scirrhus occurs in two forms, the circumscribed and the infiltrating. In the former, as its name implies, it is collected into a distinct nodule, forming an irregular tuberous mass which is not separable from the tissues in which it lies; in the latter it consists of a general induration of the tissues; when the skin is implicated in this form it becomes hard, tense, and thickened, and closely matted with the subjacent tissues. It is then said to be 'hide bound.' This form of cancer spreads slowly, gradually invading the adjoining tissues, till large surfaces of cutaneous structures become involved. The skin becomes livid from interference with the circulation, then gives way and ulcerates, forming an irregular ulcer with everted edges and nodular surface, which may tend to heal to a certain extent in one direction, while it spreads in others.

β. The **encephaloid** or **soft spheroidal-celled cancer** (fig. 65). This form of tumour is also sometimes known by the name of *medullary* cancer. It occurs as a primary growth in the breast, though much less commonly than the scirrhus; in the testicle, the ovary, the bladder, kidney, and liver, and sometimes in other viscera. It is, however, as a secondary growth that it is most frequently met with; for example, a primary scirrhus tumour of the breast is very commonly accompanied by secondary encephaloid tumours in the glands or viscera. This form of growth is soft, of a brain-like consistence and appearance, which fully entitles it to the name encephaloid which is often applied to it. The encephaloid cancers are often very vascular, and frequently contain large blood cysts caused by the giving way of one of the new-formed vessels in the growth.

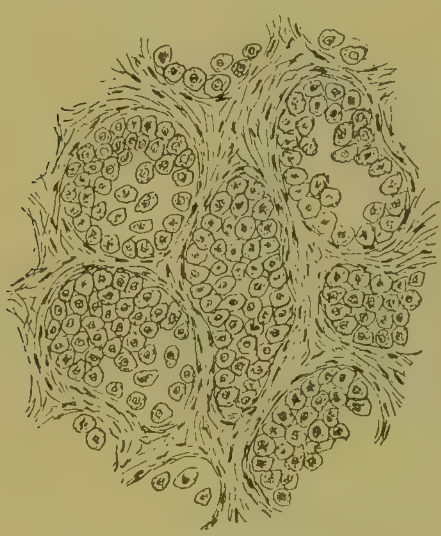

FIG. 65.—Encephaloid cancer.

There is no essential difference in structure between the hard and soft cancers. The slight difference between the two, when examined under the microscope, is due to the smaller relative amount of the intercellular stroma and the larger and rounder shape of the cells in the encephaloid tumour. Clinically this growth forms a rapidly growing mass, which is, as its name implies, soft, and may be so soft that it fluctuates like an abscess. It differs from the hard spheroidal-celled carcinoma in its more rapid growth, so that it runs a more rapid course and is more quickly fatal. It early affects the lymphatic glands, and if removed recurs with great rapidity. To a great extent in its clinical history and appearance it resembles the sarcoma; for instance, a sarcoma of the testicle can scarcely be distinguished before removal from a carcinoma of the same organ, except by the age of the patient in some cases: the latter never occurs in children. In the adult the presence of some chondrified sarcoma in the growth would at once determine the diagnosis.

These soft growths speedily make their way to the surface of the body, implicate and destroy the skin, and then begin to sprout through it, forming a fungating mass, which often bleeds furiously and causes the death of the patient from hæmorrhage.

II. **Columnar-celled carcinoma** (fig. 66). The columnar-celled carcinoma is a rarer disease than the glandular carcinoma. It originates from those structures where columnar epithelium is found, and occurs in connection with those mucous surfaces which are covered with this form of epithelium; the two most common places being the intestinal canal, especially the rectum, and the uterus. It also occasionally occurs in the antrum and air passages, in the larger milk ducts, and the gall bladder. These tumours are described by some as a variety of epithelioma; but as there is an absence of cell nests, which is one of the characteristics of this form of tumour, and as they exactly resemble the glandular forms of carcinoma in consisting of closely packed cylinders of epithelial cells, it is better to class them in a distinct and separate group.

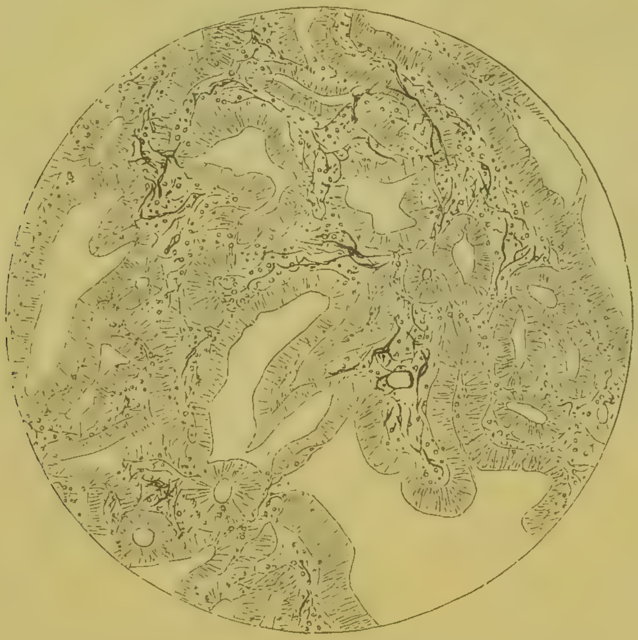

FIG. 66.—Columnar-celled carcinoma of the rectum.
(From 'A System of Surgery,' by Holmes and Hulke.)

These tumours produce an indurated mass in the wall of the organ in which they grow, and when this is a canal, as the rectum, they produce a diminution in the lumen of the tube. They, like the other forms of carcinomata, infiltrate the neighbouring structures and speedily ulcerate on their surface, forming a foul excavated crater-like cavity. When examined microscopically they are found to be composed of cylinders or tubes, lined with columnar epithelium, bound together in an alveolar stroma, which is more or less infiltrated with round cells, as in the other forms of carcinomata. As a rule they grow slowly, and are not so malignant as the other varieties. They do not affect the lymphatic glands so speedily or so frequently as the squamous carcinomata, and they are not so apt to form secondary growths as the spheroidal variety of the disease. The secondary growths maintain the form of the primary growth, so that a secondary cancerous nodule of the rectum is found to be made up of the same columns of columnar cells which are present in the primary disease.

III. **Squamous-celled carcinoma** or **epithelioma.**—This form of carcinoma takes its origin from some part of the body where squamous or stratified epithelium exists, but it is especially prone to occur at those parts where the mucous and cutaneous surfaces meet, as the lips, the vulva in the female and the anus in both sexes. It also occurs in the mouth, on the tongue, gums, and tonsil; in the larynx, pharynx and œsophagus. Cicatrices and ulcers are also sometimes attacked with this disease.

It may begin in several different ways, as a slight ulcer or fissure, as a wart or a little nodule; but in all it is characterised by the early period at which ulceration appears. In some cases this ulceration comes on so quickly and extends so rapidly that there is hardly any evidence of new growth, but generally the ulcerated surface is surrounded by a mass of indurated tissue, which is the neoplasm, and presents on section a white opaque surface, with a clearly defined margin, though there is no capsule (fig. 67). Upon microscopic examination the growth is found to consist of columns of cells, which are down-growths from the surface epithelium from which the tumour sprang (fig. 68). These cylinders of cells are not inclosed in a membrane, and have a tendency to communicate with each other in the deeper tissues forming a network. They are connected together by a fibrous stroma which is infiltrated with adventitious cells. When sections are made across these cylinders, the characteristic appearance of epithelioma is well shown. The section presents certain round or oval masses, not unlike a bird's nest, and they have therefore been termed 'cell nests.' In the centre are one, two, or more spherical cells, around which the squamous epithelium is flattened and arranged in a concentric manner like the layers of an onion. Similar cell nests are also found in other morbid growths, as the papillomata, and therefore they must not be regarded as absolutely pathognomonic of epithelioma.

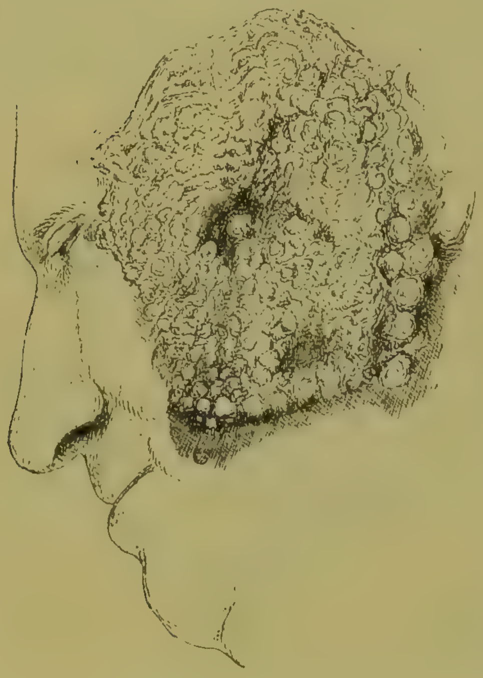

FIG. 67.—Epithelioma of the face. (From a drawing in the Museum of St. George's Hospital.)

The rapidity of the growth and the malignancy of epithelioma differ, according as it grows from different parts of the body. An epithelioma of the lip, for instance, grows slowly, and if it is freely removed may never recur; whereas an epithelioma of the tongue grows very rapidly in most cases, is very prone to return if removed, affects the lymphatic glands very early, and in most cases kills the patient in about a couple of years after its first appearance.

The chief clinical differences between epithelioma and the other forms of carcinoma are, speaking generally, that it is not so liable to dissemination and to form secondary growths in internal organs, and that it is not so liable to recur if freely removed. A more favourable prognosis may be given to a patient suffering from cancer of the lip as regards recurrence than can be given to a woman who is suffering from scirrhus of the breast.

Epithelioma is the form of cancer to which allusion has already been made in speaking of the etiology of the disease as being often produced by some local irritation. A large proportion of these cases can be clearly ascribed to some pre-existing source of irritation.

Colloid cancer.—There is a form of disease which was formerly classified as a distinct variety of cancer under the name of *colloid*, *gelatiniform* or *alveolar* cancer, but is now known to be merely a degeneration of glandular cancer. It occurs principally in the abdomen, but also occurs sometimes in the female breast. It consists of a lobulated mass, which in the abdominal cavity often attains a large size and appears on post-mortem examination to occupy the whole of the cavity, obscuring the viscera. It is semitranslucent, soft, and of a yellowish colour, not unlike honey. It consists of an open network of fibrous tissue forming large spaces in which is contained a jelly-like material. The fibrous stroma is composed of transparent fibres, beset with round or oval nuclei; while in the jelly-like material are cells of various sizes and shapes, many of them undergoing processes of degeneration ; some containing fat granules, others being surrounded by zones of granules, which give them a resemblance to an oyster shell ; in addition to this there are cells which resemble the spheroidal epithelium from which the tumour originally sprang.

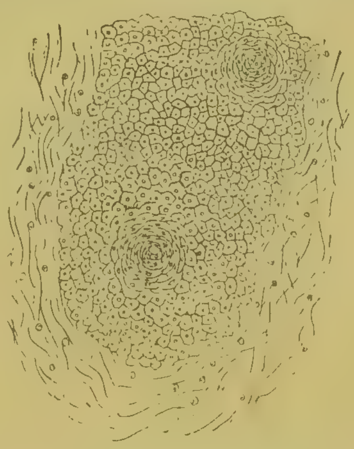
FIG. 68.—Microscopic appearance of a column of cells growing downwards from an epithelial surface, and containing two cell nests. Diagrammatic.

Treatment.—In this general consideration of the subject of cancer, it is not necessary nor expedient to say much on the subject of treatment; this will be more conveniently discussed in the sequel in considering cancer as it affects different tissues and organs. It will be sufficient in this place to allude briefly to the two ways in which cancer, speaking generally, may be treated, viz. by the palliative and the radical plan of treatment. The *palliative* treatment is employed in those cases where operative interference is contra-indicated ; such as cases where the whole of the growth and the infiltrated tissues around cannot be removed ; cases where there are several malignant tumours in different parts of the body ; or where the malignant cachexy is well marked, or there is any suspicion that there are secondary visceral growths. Here the treatment consists in soothing pain by the administration of opium, preferably by the subcutaneous injection of morphia ; in destroying the fœtor which arises from the tumour if it is ulcerated ; and in supporting the patient's strength by good nourishing diet ; avoiding as much as possible the exhibition of stimulants, which tend to increase the growth and cause pain. The *radical* treatment consists in the removal of the tumour, together with a free margin of surrounding tissue, which may be already implicated in the disease, in the hope that it may not return or develop as secondary growths in other parts. As we have already stated, some forms of cancer are much more prone to return than others. If removed early, some forms of squamous epithelioma do not as a rule return, and the same may be said, though to a considerably less degree, of the scirrhus and columnar cancer. Still, it must be admitted that recurrence after removal is the rule. But even if cancer cannot be cured by the knife, there can be no question that life may be prolonged and the health improved by an operation; and in addition to this the patient may die from the implication of internal organs, and therefore his death is easier and entails less suffering than if an external cancer has been left to ulcerate, fungate, and bleed, and cause intolerable pain and suffering.

CHAPTER X

SURGICAL DISEASES DUE TO PARASITES

THE term **Animal Parasite** includes 'all those forms of creatures which in a direct manner, by dwelling in or upon other living animals, or by merely visiting or momentarily alighting on the surface of the body, are thus enabled to acquire means of subsistence' (Cobbold). Etymologically, a parasite means one who feeds on or with another (*para*, beside ; *siteo*, I feed), and therefore an animal parasite means an animal which lives on another. So that the term would include all those microbes, such as those of glanders, anthrax, &c., which we have already considered. In this place we shall briefly allude to those other varieties of creatures which take up their residence in the tissues of the body and produce diseases which are usually recognised as surgical, excluding, however, those creatures which only temporarily sojourn on the surface of the body for the purpose of obtaining food, and do not *live within* their host, such as mosquitoes, bugs, fleas, &c.

ECHINOCOCCUS

The **echinococcus** is a tapeworm about a quarter of an inch in length which infests the intestinal canal of the dog, wolf, and jackal. Its ova find their way into the stomach of the human subject in water or food contaminated by the excrement of one of these animals. As soon as the ova enter the stomach, their capsule is dissolved by the gastric juice, and the liberated embryo, by means of hook-shaped processes with which it is provided, bores its way through the coats of the viscus, frequently entering a blood-vessel, and by it is carried to different parts of the body, where the embryo develops into the so-called bladder stage, producing an *hydatid cyst*. The liver, presenting the first set of capillaries through which the embryo has to pass, is the most frequent place in which arrest takes place, but by no means the only one, for hydatid cysts have been found in almost all the organs and tissues of the body.

When lodgment of the embryo has taken place, a capsule of fibrous tissue forms around it, as the result of irritation and inflammation of the neighbouring tissues. To this the name of *ectocyst* is given ; within this is the wall of the true cyst, called the *endocyst*. This latter is a semitransparent, elastic membrane, which consists of two layers, an outer laminated layer, which curls up in a characteristic fashion when liberated, and an inner germinal layer from which the scolices or heads of the tænia are developed. These are just visible to the naked eye, as minute solid bodies attached by a constricted neck or stalk to the interior of the cyst. They are provided with four section discs and a ring of hooklets, which lies during life retracted into the middle of the head (fig. 69). If the scolex dies these hooklets are cast off, and can usually be found in large numbers in the hydatid fluid.

The fluid contained in the cysts is a clear, colourless fluid, of a low specific gravity (1004 to 1007), containing a considerable quantity of sodium chloride and no albumen, or, if any, the faintest trace. The cyst may be single, or it may contain daughter cysts, and these in their turn may inclose a third, a fourth, or even more generations. Again, daughter cysts may be formed on the outer surface of the parent cysts by a protrusion of the germinal layer through the cuticular layer of the cyst. Not uncommonly the parasite dies, when the fluid is absorbed, the cyst wall becomes shrunken, and a solid mass, which may calcify, is formed. In this way spontaneous cure may be effected. In other cases suppuration may occur and the abscess burst externally, and cure be brought about.

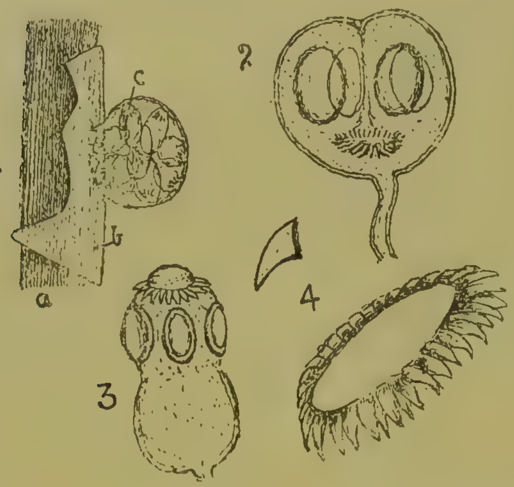

Fig. 69.—An hydatid. 1. A portion of the endocyst; *a*, the outer, laminated layer; *b*, the inner germinal layer; *c*, a daughter cyst. 2. A scolex with a stalk or pedicle, the suction discs retracted. 3. A scolex with the suction discs and ring of hooklets protruded. 4. A ring of hooklets.

An hydatid cyst may rupture and cause the death of the patient.

Symptoms. — The symptoms vary with the position of the cyst. They are those of a collection of fluid in a cavity and those which are produced by pressure upon adjacent parts. A special characteristic is the so-called 'hydatid thrill,' which is, however, by no means always present. It is obtained by placing the tips of the fingers of the left hand on the tumour and then tapping the middle finger; a peculiar vibratory thrill will be perceived in the other fingers.

Treatment. — The treatment consists in removal of the whole tumour, if practicable; otherwise in exposing and laying open the tumour and evacuating its contents and subsequently draining. When the hydatid cyst is in the abdominal cavity this is most safely accomplished in two operations. The cyst is first exposed, and, if of sufficient thickness to allow of its being done without opening it, is attached to the parietal peritoneum at the margin of the wound in the abdominal wall and left there for four or five days before it is incised. If this cannot be done it must be drawn into the wound and left there, the wound being packed to insure gaping, and after adhesions have formed it must be opened. When the cyst is incised the true cyst wall can generally be evacuated, as it is but loosely adherent to the ectocyst. On no account should an attempt be made to cure an abdominal hydatid by aspiration, for fear of leakage of some of the fluid into the peritoneal cavity, which might be followed by the gravest results.

Bond has recently advocated the treatment of hydatids by opening the capsule and removing the cyst and its contents, and dropping back the adventitious capsule without drainage, and this plan has been largely adopted by Australian surgeons in cases of intra-abdominal hydatid tumours, with a considerable proportion of success. In cases of hydatid of the lung it would appear to be still desirable to adopt the old method of incision and drainage.

ACTINOMYCOSIS

Actinomycosis is a parasitic disease caused by the invasion of the tissues by a microscopic fungus, the *actinomyces*. The disease occurs both in man and animals, and by some is considered to be transferred from the latter to the former, but there is no direct evidence of this. In man the commonest seat of infection is the alimentary canal and especially the mouth, but it may also occur as a primary disease in the respiratory tract. There is a considerable amount of evidence to prove that the fungus is contained in corn and barley, and that the disease arises from chewing these, and that man and animals are infected in the same way, from some slight abrasion of the mucous membrane through which the fungus effects an entrance.

Symptoms.—The introduction of the fungus is followed by the formation of a hard swelling, of an inflammatory nature, generally about the jaws or mouth; this enlarges and invades all the tissues in the neighbourhood. After a time it gradually softens and breaks down: the skin over it becomes dusky red, and it eventually bursts, and gives exit to a thin slimy pus, in which yellowish particles, like grains of sand, may be distinguished. This opening forms a fistula which does not heal. The tendency of the disease is to spread and form numerous fistulous openings. The condition presents some resemblance to tuberculosis, but the diagnosis may be made by a microscopic examination of the yellow particles. When the disease attacks the jaws, it slowly creeps around them, and then infiltrates neighbouring structures, the cheek, the parotid, and submaxillary region, and prevents the patient from opening the mouth. There is usually but little pain or constitutional disturbance. The disease may appear in any part of the body as the result of secondary embolic deposits. It is essentially chronic in its nature, but usually terminates fatally from exhaustion or lardaceous disease.

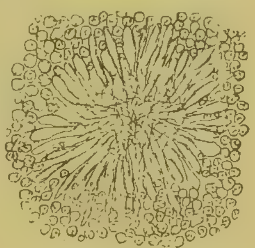

FIG. 70.—Section of Actinomyces granule.

The **fungus**, which is sometimes known as the *Ray fungus*, is to be found in the discharge from the sinuses; in the inflammatory tissues which constitute the swelling; in the fæces, where the alimentary canal is affected; or in the urine, where the kidneys are involved. It consists of a yellowish body of a round or mulberry shape, which is visible to the naked eye. Examined under the microscope it presents a very characteristic appearance, resembling a rosette (fig. 70). In the centre of each ray fungus is a mass of interwoven threads, contained in a hollow capsule, which is deficient at one point, and through this some of the threads pass out into the surrounding tissue. Around this central body, which is called the *conidiophore*, radiating in all directions are a series of club-shaped processes or rods, which are named *conidia*, which resemble the spokes of a wheel, radiating from the axis. This is invested on all sides by a round-celled infiltration.

Treatment.—Extirpation is the only remedy. When the whole disease can be removed by excision, this is by far the better plan; but when this cannot be done, thorough scraping with a sharp spoon must be resorted to, and the surface of the wound painted with strong carbolic acid or chloride of zinc solution (gr. xl to ℥j). The operation will probably require repeating. Iodide of potassium is said by some to be a specific for this disease when administered internally, but in the practice of other surgeons no good results have followed its administration. When the viscera are involved, nothing can be done beyond supporting the patient's general health.

DELHI BOIL

The **Delhi,** or **Aleppo, Boil** is a local ulcer endemic in certain localities in India, especially in Delhi, hence its name.

It is believed to be the result of invasion by an organism, the nature of which has not been discovered, but which is supposed to have its habitat in the tank water used for washing. The sores usually occur on the exposed surfaces of the skin, especially the face, which seems to indicate that the virus may be carried to the part by winged insects. Vandyke Carter has discovered the mycelium and spores of a fungus in the tissues of the affected part, but it is by no means proved that this is the real cause of the disease.

Symptoms.—After a period of incubation, the duration of which is unknown, intense itching sets in at the seat of inoculation; this is followed by the formation of a red pimple, which enlarges and becomes button-shaped, and hence the disease is sometimes called the Delhi button; it is of a dull red colour and is limited to the skin and subcutaneous tissues. After some time, probably weeks, serum begins to exude from it, and drying forms a scab, which on separating leaves an ulcerated surface, which spreads, and to a great extent resembles lupus; so much so, in fact, that many have considered that the disease was in reality a form of lupus. The sores, which are oval in shape, with sharp margins and unhealthy surface, may be single or multiple. They heal very slowly, and, like lupus, give rise to considerable deformity from contraction of the scar tissue.

The tendency is to recovery, especially if the patient leave the infective district; but the disease may last for months before cicatrisation takes place.

Treatment.—The treatment consists in the earlier stage in destroying the papule with the actual cautery or the acid nitrate of mercury. After ulceration has taken place, the sore should be thoroughly scraped and dressed with iodoform. It is desirable if possible that the patient should leave the district, or at all events that all water used for washing should be previously boiled.

MYCETOMA

The **Mycetoma** or **Madura foot,** so called from its being most commonly found in the district of Madras, though it is met with in all parts of India, is a chronic inflammatory disease of the foot, due to the entrance of a vegetable parasite.

The disease consists in a chronic inflammation commencing in the connective tissue of the foot and thence spreading to the other tissues, but especially the cancellous tissues of the bones of the tarsus, leading to the formation of abscess cavities in this structure, with numerous tortuous fistulæ by which they communicate and also discharge on the surface (fig. 71). The disease occurs especially in the natives, who work barefooted in the fields, and may also, though not commonly, attack the hands. In the abscess cavities and in the discharge from them are black masses of the fungus resembling fish roe, and also yellow particles, which are believed by some to be caseous or fatty material, by others to be a separate form of fungus.

Symptoms.—The disease is usually very chronic, and begins as a small hard spot on some part of the foot, frequently between two toes. This breaks down and a little pus is discharged, and instead of healing, a fistula or sinus is formed. In the same way other fistulæ are formed in the tissues around, the foot swells and becomes two or three times its natural size, and eventually riddled with discharging sinuses, from which purulent fluid, containing the black granules, discharges. The disease may progress for months or even years before the foot becomes useless, and is unattended by any constitutional disturbance. Recovery would appear never to take place, but the disease may last for twenty or thirty years without causing the death of the patient.

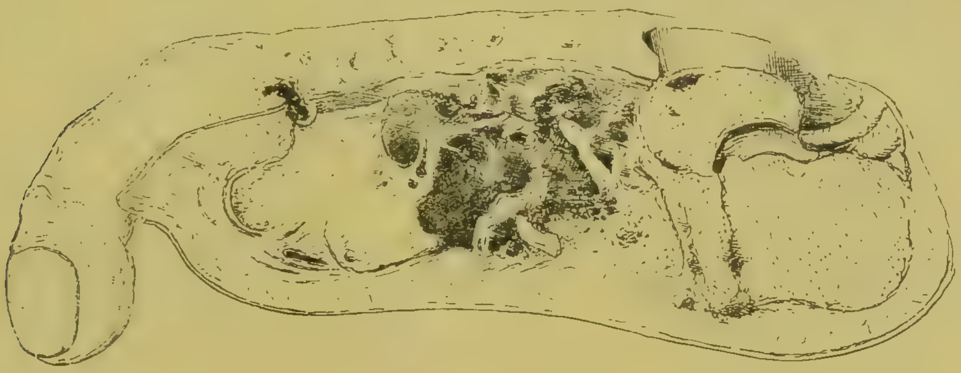

FIG. 71.—Madura foot. (From a preparation in the Museum of St. George's Hospital.)

Treatment.—In the early stages of the disease an effort should be made to save the foot by a thorough scraping away or excision of the disease, but generally before the patient applies for treatment and the disease is recognised, it is too far advanced to admit of this treatment, and then amputation is the only resource.

JIGGER WORM OR CHIGOE

The **jigger worm** is an insect which infests the sand of the tropics of America, Africa, and the West Indies, and attacks the bare feet, especially of children, whose skin is thin and less callous than that of the adult. The insect belongs to the flea tribe, but is only about one half the length of the common flea, and is armed with a sharp proboscis. It is the impregnated female which finds a home under the skin, through which she perforates her way by means of her sharp proboscis, the most usual site of entrance being between the toes or under the toe nails. Here she remains until her eggs reach maturity, causing inflammation and suppuration in the surrounding tissues. If the embryos become diffused into the tissues around, they may cause troublesome ulceration and the formation of sinuses.

Treatment.—As soon as the insect effects an entrance, it should be removed entire with the point of a needle. If it is injured during extraction, a point of caustic should be introduced into the little opening.

THE GUINEA WORM

The **Guinea worm** (*Dracunculus ; Filaria medinensis*) is a nematode worm, peculiar to tropical climates, especially the West Coast of Africa. The ova of this worm appears to reside in the mud of tanks and ponds. Here it perforates the skin of a minute aquatic crustacean of the genus Cyclops, which acts as an intermediate host, and here it attains its full larval condition. It is then transferred, together with its host, to the stomach of man, in the water which he drinks.

According to Fedschenko, the larva consists of both male and female, and impregnation takes place in the stomach, after which the male perishes and the female bores her way to the surface of the body, generally of the lower extremity. Here it develops into a worm of from three to six feet in length, which lies coiled up in the tissues. It is cylindrical in shape, of a white colour, and has a rounded head. Eventually a vesicle is formed, which bursts and the head protrudes.

Symptoms.—The symptoms consist in the formation of an elongated swelling, not unlike a thrombosed vein, generally on the lower extremity. This is followed by the formation of a vesicle on its summit, which bursts and discharges a fluid, which is sometimes clear and sometimes turbid. Acute, deep-seated inflammation may now be set up in the tissues around with severe constitutional disturbance.

Treatment.—If possible the entire worm should be excised ; if this cannot be done, it is better to allow it to discharge itself spontaneously and not to attempt to drag it out, as is sometimes done by the natives in those countries where the disease is endemic. There is danger of the worm being torn and part being left in the tissues, when its decomposition induces severe suppuration and serious general symptoms.

TRICHINA SPIRALIS

The **trichina spiralis** is a nematode worm which has its habitat in the muscles of many of the mammalia, but especially the pig. When introduced into the alimentary canal of the human being it develops embryos, which find their way into the voluntary muscles, and there take up their abode. The disease generally arises from eating 'measly pork,' which has been imperfectly cooked. When introduced into the alimentary canal of man they develop with extraordinary rapidity, and generate a large number of embryos, which find their way through the lymph stream into the general circulation, and are carried in the blood to the muscles, where they become fixed. The embryo here develops into a worm, which assumes a rolled-up form, inclosed in a capsule formed by the condensation of the surrounding tissues (fig. 72). It is of about half an inch in length in its mature condition. After the process of encystment is completed the worm remains quiescent, and all local symptoms cease. It may perish and the capsule become calcareous.

Symptoms.—In some cases where the amount of 'measly meat' ingested has been large, there may be immediate symptoms of intestinal irritation. Within a few hours there may be nausea and sickness, with vertigo and a rise in temperature, and this may be followed by diarrhœa. In cases where less has been ingested, there may be simply a feeling of malaise and loss of appetite. In about a week, stiffness and rigidity of the affected muscles set in; they become swollen and extremely painful to the touch, and any attempt to put them in action is accompanied by excruciating agony. Accompanying these local signs there is grave constitutional disturbance. The temperature is raised, the pulse rapid, and the respiratory movements increased in frequency. There is sleeplessness, and very often delirium. Often there is also diarrhœa, which further exhausts the patient. If death ensues, it is generally in the third or fourth week; but if the patient survives a month or so, the constitutional symptoms usually begin to abate, and the patient's strength gradually returns.

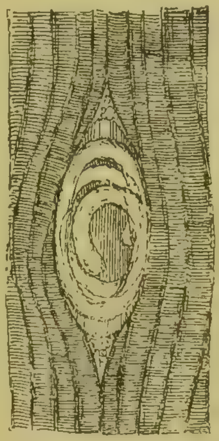
Fig. 72.—The trichina spiralis inclosed in a capsule in a voluntary muscle.

Treatment.—If the disease is recognised immediately on the occurrence of the first symptoms of intestinal irritation, an emetic followed by a brisk mercurial purge may expel the trichinæ at once and relieve the patient; but if active migration and colonisation of the embryos has taken place, the case must be treated on general principles, with a view to lessening the fever and supporting the powers of the patient.

FILARIA SANGUINIS HOMINIS

The **filaria sanguinis hominis** is a nematode worm, which gains access to the body through the alimentary canal. It is supposed to be transmitted through the mosquito as an intermediate host. This insect abstracts blood, containing embryos, from infected bodies. These embryos undergo maturation in the body of the mosquito, and this insect, after depositing its eggs on water, dies and falls into the water, and through this means the worm gains access into the human alimentary canal. It migrates thence into the lymph stream, and here it produces many embryos, which pass into the general circulation. So that the filaria exists in the human body in two distinct forms, as the mature animal in the lymphatic vessels, where it may produce lymphangitis and abscess, and as the embryo, which may obstruct the lymph stream and be followed by varicose dilatation of the lymphatic vessels (lymphangiectasis) and lymphatic œdema; or a communication may be established between the dilated lymph vessels and some part of the urinary tract, and a condition of chyluria is set up, in which the urine has a milky appearance and coagulates on standing.

BILHARZIA HÆMATOBIA

The **bilharzia hæmatobia** is a trematode worm, which gains entrance into the human body through the alimentary canal, the embryos being ingested with drinking water. The disease occurs in tropical climates, but is especially severe and common in Egypt. From the alimentary canal the embryos find their way into the portal circulation, and reach maturity in cavities in the radicles of the portal vein, or the vein itself, or sometimes in the vesical veins, and these produce numerous ova, which tend to reach the mucous surfaces and there escape, especially through the mucous surfaces of the urinary organs.

The most prominent symptom of their presence is hæmaturia, accompanied by pain and frequency of micturition. The blood may be passed with the urine or at the end of the act of micturition, and often contains clots in which the worm is found. The hæmaturia may be, and often is, intermittent.

Treatment.—No specific remedy is known for this disease, which has a tendency to wear itself out if the patient is removed from the source of infection. The liquid extract of male fern and methylene blue, in 5-grain doses, is said to be beneficial, at all events in relieving the strangury.

SECTION IV

INJURIES AND DISEASES OF SPECIAL TISSUES AND ORGANS

CHAPTER I

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES

Warts (Verrucæ).—A wart is a true papillomatous tumour, and in structure differs in no respect from an ordinary papilloma, except in those slight differences which are due to the structure from which it grows. Warts occur principally in children about the hands and face, and in adults about the genital organs. They may also occur on mucous surfaces, as the conjunctiva, or in the mouth.

Etiology.—No cause is certainly known for warts, but in all probability in most cases some form of local irritation is the primary cause of the disease. This is certainly the case in warts on the genital organs of the adult, where they arise from the irritation produced by some retained secretion, or from the discharge of gonorrhœa. In the common warts on the hands of children they may possibly be due to the irritation produced by dirt, for they generally disappear spontaneously as the child grows older, and when probably more attention is paid to personal cleanliness. Warts sometimes depend on secondary syphilis for their origin.

Warts are generally pedunculated, but occasionally sessile, especially when they occur on the face of old people. Not infrequently a crop of small warts collects into a mass on some part of the body, and under these circumstances is often pigmented. They have received the generic term of *verrucæ confluentes.* The colour of a wart varies; sometimes it is grey, sometimes red, and sometimes brown or black from the presence of pigment. It is very vascular, and often bleeds considerably after a slight injury, which ruptures the vessel it contains.

Treatment.—Almost any caustic will cure a wart; perhaps the most satisfactory is the glacial acetic acid; this applied to the wart, with strict cleanliness, is generally all that is necessary. Warts on the genitals must be treated by scrupulous cleanliness, the application of the liquor plumbi diacetatis, or a powder consisting of equal parts of iodoform and tannin. If this fails to effect a cure, snipping them off with a pair of scissors and touching the pedicle with the actual cautery is required. If there is any gonorrhœa present, it must be treated; and if there is any suspicion as to their specific nature, the constitutional disease must be treated. Epsom salts has gained some reputation as a cure for warts, especially when they are multiple. It should be given in small doses two or three times a day, so as to produce three or four actions of the bowels daily.

Corns.—A corn is primarily a thickened mass of epidermis, caused by intermittent pressure. It is almost always found on the foot, and arises from the pressure of ill-fitting boots. It is something more than the thickened epidermis which is found on the palms of the hands of labourers and rowers, or on the fingers of seamstresses or musicians, for the thickened epidermis causes absorption of the papillary layer of corium immediately beneath, so that it lies as a conical mass in a sort of pit in the true skin, around which the papillæ are enlarged from irritation. In old corns, a bursa may develop beneath the thickened tissue from the continued pressure, and this may inflame and suppurate.

Corns are of two kinds, hard and soft. The **hard** corn usually occurs on the dorsal surface of the toes, especially the outer and upper surface of the little toe. It may also occur on the sole of the foot, over the heads of the metatarsal bones. In cases where the bursa under a corn in this situation suppurates, the pus, unable to find an exit through the thickened epidermis, may burrow in the tissues and may give rise to a spurious form of perforating ulcer. In cases of hammer toe a very troublesome corn is apt to form over the prominence of the flexed interphalangeal joint, which can only be cured by straightening the toe by operation. The **soft** corn occurs between the toes, and partakes more of the character of a wart than a corn, consisting of elongated papillæ covered by thickened epithelium; it is probable that it is produced, like a wart, from the irritation of dirt and sweat collecting between the toes, and not, like a corn, from intermittent pressure. Corns are acutely painful, and from their position often prevent a patient from taking active exercise. It is a curious fact that patients often complain more of the pain from their corns in damp weather. Independently of pain, corns may produce other troubles: the suppuration under a corn may expose a bone, or open and destroy a joint—they are not infrequently the cause of lymphangitis, and in old people may be the starting point of senile gangrene.

Treatment.—The first point in the treatment of a corn is to see that the patient is properly shod. He or she should have boots carefully adapted to the foot, with a good breadth at the toes, and low heels. There is no more prolific cause of corns than the high heels worn by some people, which cause the toes to be tightly wedged into the end of the boot. Well-fitting boots, and the application of a 'corn plaister,' is generally all that is necessary to effect a cure. The corn plaister consists of a round piece of felt covered on one side with diachylon, with a hole in the centre to receive the corn. It may be desirable, if the corn is of large size, before the plaister is applied, to soak the foot in hot water and then pare away the thickened cuticle with a scalpel; but in most cases, if the plaister is steadily worn for a time and the boots fit, the thickened epidermis will desquamate and the patient will suffer no further inconvenience.

Moles are overgrowths of the skin, which form raised pigmented patches of a brownish or black colour, and from which short crisp hairs constantly grow. They are always congenital, and may remain quiescent, without any tendency to grow, for years, causing no inconvenience beyond the disfigurement which they produce when situated on some exposed portion of the body. They occasionally become the seat of troublesome ulceration, probably set up by the friction of the clothes.

The most important point in connection with the life history of moles is the tendency which they have occasionally to become the seat of a sarcomatous growth. They then constitute the form of tumour already described as melanotic sarcoma (see page 248), and this may rapidly kill the patient. When situated on some exposed part of the body, as the face, the surgeon is sometimes called upon to remove them on account of the disfigurement which they occasion. When they are small this can easily be done by two elliptical incisions, the edges of which can be sutured, and a mere linear cicatrix will remain. But when, as is often the case, the mole covers a considerable surface of the skin, this cannot be done. Two courses are then open to the surgeon. One is to excise the whole of the growth, and then cover the rawed surface by Thiersch's method of skin grafting. The result is not, however, very satisfactory, and the disfigurement produced by the graft is almost as great as the original deformity. The other plan is to shave off the greater part of the thickness of the skin, so as to leave only the deepest layer. By this means all the pigmented structures are removed, and still there is enough cuticular structure left to form a new skin, rather than scar tissue, so that no contraction takes place. This operation, which requires great care and nicety so as to remove enough but not too much of the skin, is best performed by a rotatory circular knife worked by electricity.

Morphœa is a disease to which a second name, *circumscribed scleroderma*, has been most aptly applied, for it consists of an area of induration of the skin and tissues beneath, which appears like a patch of hide-bound skin, slightly raised above the surrounding integument, quite smooth on its surface and of a pearly whiteness or greyish colour. After its formation it contracts and draws in the surrounding skin, producing a puckered margin. It was first described by Dr. Addison under the name of 'true keloid,' but it has little in common with the keloid of scars, which has already been described. Its cause is unknown, and no treatment appears to be of any avail. Beyond the disfigurement which it causes, it is not a condition of much importance.

Xanthelasma is a disease of the integument due to the presence of cells of irregular size and shape, which produce a raised patch of a yellowish white colour. It is found, for the most part, in patients who suffer from jaundice. It may occur in any part of the body, but appears principally to affect the skin of the upper eyelid, especially towards the inner canthus. It may occur either as tubercles or nodules, or more usually as plaques or patches, with a well-defined margin and of a yellow colour. Nothing is known about the etiology of this rare condition, but it has been thought by some that it may be due to some functional disorder or structural disease of the liver. In the way of treatment, nothing short of excision, if it should be thought expedient to interfere, is of any avail in removing the disease.

Molluscum contagiosum is a chronic disease of the skin, characterised by the formation of small, rounded, umbilicated tumours which rarely exceed the size of a pea. The disease most frequently occurs in children, about the face and neck, but it is also seen in the adult, especially about the genital organs and inner side of the thighs. The tumours grow slowly and appear as pinkish white nodules attached to the skin by a somewhat constricted base. On the top of each is a central pit or depression: this and their colour have caused them to be compared to a pearl shirt button. When examined microscopically, they are found to consist in the centre of large oval, vitreous-looking bodies, which are known as the molluscum bodies, which are by some considered to be parasitic in their nature. These are surrounded by peripheral cells, which are closely associated with the Malpighian layer of the skin and are closely packed together. They produce no constitutional symptoms, and are of little importance beyond their unsightliness. The **treatment** consists in making a slight puncture into them and squeezing out their contents. They show little tendency to recur.

Lupus.—Lupus is a disease of the skin, characterised by an infiltration of the corium with small round cells. It may attack any part of the body, but is most frequently found on the skin of the face.

Under the term lupus are described two forms of disease, which, though they have much in common, present great points of difference and require to be examined separately. These are: (1) lupus vulgaris and (2) lupus erythematosus.

1. **Lupus vulgaris** is the more common form of the disease. It usually commences in childhood or early adult life. It has a much greater tendency to ulcerate and destroy the tissues more deeply than the other form. It may also attack the mucous surfaces, sometimes primarily, but more frequently by extension from the cutaneous surfaces.

The disease begins as an accumulation of round cells, which forms a distinct spherical nodule in the deeper layers of the corium. This increases in size and destroys the whole thickness of the true skin, so that we get a nodule of tissue similar to granulation tissue contained in an excavation of the true skin and covered by the epidermis; in this granulation-like material are found non-vascular areas resembling in structure miliary tubercles, consisting of a giant cell, surrounded by large epithelioid cells and inclosed in the round cells of the granulation tissue. The presence of these tuberculous nodules, when they were first discovered, led pathologists to the opinion that lupus vulgaris was a tuberculous disease of the skin, and this was further confirmed when the tubercle bacillus was found in the giant cells. The bacilli are few in number, never perhaps more than one in each giant cell, and they are difficult to find. Further confirmation of this opinion was derived from experimental research, when it was found by Schuster and others that inoculation of lupous material into animals sometimes produced general tuberculosis. After full development of the lupoid tubercle has taken place, and the individual tubercles have coalesced to form a mass of considerable size, the

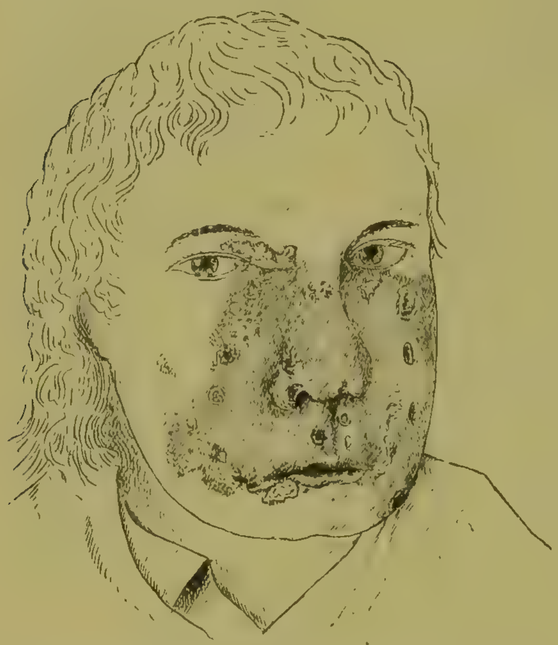

FIG. 73.—Lupus vulgaris of the face. (From a drawing in the Museum of St. George's Hospital.)

cells of the growth begin to undergo a fatty degeneration, but this change does not take place to the same extent in all instances. In some cases only a portion of the cells undergo this change, and these break up and are absorbed, while the remainder become spindle-shaped and converted into fibre cells and fibrous tissue, so that the original lupoid tissue is replaced by scar tissue, and forms a permanent, slightly depressed, whitish cicatrix, which has a great tendency to contract and produce deformity. This is known as the non-ulcerative form of lupus—*lupus non exedens.* In other cases the fatty degeneration affects all the cells, and the whole growth caseates, softens, and breaks down, forming a foul ragged ulcer, which slowly extends. This is the ulcerative form of lupus—*lupus exedens* (fig. 73). The ulcer thus formed may heal under treatment, and then forms a cicatrix, which, like the cicatrix of the non-ulcerative form, has a tendency to contract and produce deformity.

Symptoms.—The disease commences by the formation of one, two, or more amber-coloured, semi-transparent nodules, most frequently in the situation where the ala of the nose joins the lip. From their colour and semi-transparent appearance they have been compared to apple jelly. The colour does not entirely disappear on pressure. The nodules increase slowly and become slightly elevated, and fresh nodules appear in the immediate neighbourhood, which after a time coalesce with the first formed. They now present the appearance of a flattened mass of the same semi-transparent amber colour, incorporated in the skin and covered by epithelium which shows a tendency to desquamate.

If the disease now takes on the non-ulcerative form, the mass begins to contract, and finally disappears, leaving a dense, white cicatrix, around which may be an 'apple-jelly' ridge of advancing disease. If, on the other hand, the tubercle is about to ulcerate, it becomes pale and soft, the epithelium over it disappears, and it eventually bursts, discharging a caseous material and leaving a sharply defined ulcer with raised edges and a foul, unhealthy surface. This sore may gradually extend both superficially and also deeply into the tissues, destroying the alæ of the nose, but rarely attacking the bones. In this way it may produce the most hideous deformity and may last for years. It, however, in no way affects the general health ; the patient may be robust, florid, and in all other respects perfectly healthy. In old-standing cases it may sometimes become epitheliomatous. The only difficulty in the diagnosis is that it may be mistaken for tertiary syphilitic ulceration, but the age at which it began, the history of the case, and the absence of any other signs of syphilis, are generally sufficient to indicate the nature of the disease.

Treatment.—Local measures must be principally relied upon in the treatment of simple lupus, but these are not always successful, and relapses are very apt to occur, as it is exceedingly difficult to eradicate the whole of the infiltration. Hence the great importance of recognising early and treating vigorously every patch of lupus. The modes by which the disease may be eradicated are excision, scraping, the actual cautery, and caustics. Of these excision is by far the best and most radical, but can only be applied in those cases where the disease is recognised in its early stage, and is therefore limited in extent. In most cases recourse must be had to scraping, and this should be done very thoroughly with a sharp spoon. The combination of the actual cautery with this is generally of advantage, and it is wise to touch the whole of the excavated surface with a fine-pointed cautery. Caustics are not so reliable ; when weak they do more harm than good, and when strong they may destroy healthy structures, and produce greater deformity than is necessary. After scraping the best local application is iodoform, which is said to be inimical to the tubercle bacillus. In spite of the utmost care, in a large number of cases the disease will return and require a repetition of the operation.

Formerly considerable reliance was placed upon constitutional treatment in these cases, but the beneficial results obtained have not been found to be great. Nevertheless, removal to a warm and equable climate usually benefits the patient; beyond this, attention to the general health is all that can be done.

2. **Lupus erythematosus.**—Like the preceding form, lupus erythematosus consists in an infiltration of the corium with small round cells, principally, however, affecting the sebaceous glands and surrounding tissue. It differs from lupus vulgaris in several important particulars. It is a disease of adult life, rarely occurring before twenty. It is not prone to ulcerate, and it shows a very marked tendency to symmetry. Though by many the disease is supposed to be tuberculous in its nature, there is no evidence to prove that it is so, beyond the fact that it is said to occur in members of tuberculous families and to be often associated with other tuberculous lesions. The tubercle bacillus has not been found in the cell infiltration, and inoculation experiments have given negative results.

The disease commences as an hyperæmia around the sebaceous glands, attended by a round-celled infiltration. The glands themselves become dilated, and their secretion, increased in quantity and exuding, forms greasy scales on the surface of the lupous patch. As the disease progresses, the infiltration cells destroy and replace the gland tissue, and then, in their turn, become converted into cicatricial fibrous tissue.

Symptoms.—The disease begins as a sharply defined red patch on any part of the body, but most usually on the face—the side of the nose or cheek. Frequently there is a patch on either side of the nose, joined across the bridge, and this as it extends gives to the disease its characteristic appearance of a butterfly, a large patch on either cheek, connected by a narrow strip on the nose. The reddened patch, which fades on pressure and often causes considerable itching, soon becomes covered with the dried sebaceous discharge, which forms an adherent crust. When this is removed, plugs of sebaceous matter, which adhere to its under surface, are drawn out of the dilated follicles. As the disease advances at its circumference the first formed parts become pale, shrunken, and cicatricial in appearance, resembling the scar of a superficial burn, so that the disease soon presents the appearance of a central depressed scar, with a bright red raised margin. There is no tendency to suppuration or ulceration, but the scar tissue, after its formation, contracts and produces puckering and great deformity of the features.

Treatment.—The treatment of this disease is not satisfactory: no remedy appears to have any direct influence upon it. Perhaps the best results have been obtained by linear scarification, which, however, requires repeated applications for a very considerable period. Various drugs have been recommended; the one which has answered best in my hands is the ammonio-chloride of mercury in the form of an ointment of the strength of a drachm to an ounce; tincture of iodine painted over the part daily also seems to do good. Hebra recommends a mixture of equal parts of soft soap and alcohol to be rubbed into the patch daily with a piece of flannel; and others, tar ointment.

Scrofuloderma is a disease closely allied to lupus, but still differing from it in some essential particulars. It is a disease occurring in tuberculous subjects, and characterised by the formation of a localised tuberculous focus immediately beneath the skin. This is termed a *tuberculous node* or *tuberculous gumma*. It is fixed, and the skin over it is normal. It is not usually painful, but tender on handling. It slowly increases in size and softens, and the skin covering it becomes purple. Finally the skin gives way at one spot, and a small amount of thin curdy pus is discharged, leaving a cavity which is covered in by the thin, purple, undermined skin. This forms a *tuberculous ulcer*, and exactly resembles the condition which is so often seen in the necks of tuberculous children from disease in the cervical glands.

The **treatment** consists in cutting away the undermined skin, freely scraping the floor of the ulcer, and applying iodoform ; at the same time treating the constitutional condition.

Rodent Ulcer.—Anatomically rodent ulcer is a carcinoma and is locally malignant, but it differs from ordinary carcinoma in being of much slower growth ; in not being disseminated ; in not involving the lymphatics ; and in not returning if thoroughly removed.

It is a disease of advanced life, rarely occurring before the age of fifty. Nothing is known as regards its cause, but it very often commences on some pre-existing morbid condition, as a wart or a mole. It may occur in any part of the cutaneous surface, but is much more frequently found on the head and face than any other part of the body ; its particular seat of election being the upper half of the face, and especially the inner angle of the eyelid, the temple, and the forehead. It always begins in the skin.

Symptoms.—When it commences in healthy integument, it usually appears as a small brownish red nodule, which breaks down, ulcerates, and forms a sore ; this spreads slowly, gradually eating away and destroying everything with which it comes in contact. In this way, having destroyed the skin, it invades the tissues beneath, connective tissue, muscles, &c. If it commences at the inner angle of the eyelid, it may destroy the tarsal cartilages, invade the orbit, and destroy the eye : if it commences on the temple, it may destroy the parotid gland and the cartilage of the ear, and creep down the external auditory meatus and destroy the tympanum ; and if it commences on the forehead, it may eat through the bone and expose the dura mater. When fully formed the ulcer presents a somewhat depressed base, with slightly raised, irregular, tubercular edges, which are sharply defined. The surface of the sore is of a pinkish red colour and devoid of granulations. Occasionally an attempt at cicatrisation will take place at one part of the ulcer. The ulcerative process will cease at one part of the margin of the sore ; a thin bluish film of cicatrisation will

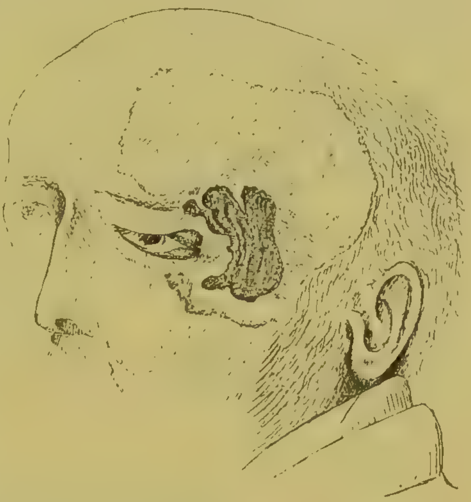

FIG. 74.—Rodent ulcer. (From a drawing in the Museum of St. George's Hospital.)

start from this point and sometimes spread over a considerable part of the sore, but at the same time it will continue to extend in other directions (fig. 74). This scar tissue which is thus formed is, however, of very feeble vitality, and is very apt to break down again and disappear, and unlike ordinary scar tissue shows no disposition to contract. In this way the disease may go on for years, gradually spreading and increasing in size, until in some extreme cases a considerable part of the face may be eaten away, producing the most hideous and distressing deformity. All the time the patient's health remains good, and an individual who has suffered from rodent ulcer for years may present an appearance of robust health, with a florid complexion and full muscular vigour. It never affects the lymphatic glands, and those cases in which the lymphatic glands have been reported to have been enlarged are probably instances in which the enlargement has been due to some irritation produced by the application of caustics or some irritating material to the surface of the sore.

The **diagnosis** of rodent ulcer ought not to be difficult. It may be mistaken for tertiary syphilitic ulceration, lupus, or epithelioma. From syphilitic ulceration it may be distinguished by the history of the case and the duration of the disease and by the absence of any other signs of syphilis ; from lupus by the age and general appearance of the patient and by the absence of the thin, purplish, undermined edge of the tuberculous ulcer ; and from epithelioma by the prolonged course of the case, the healthy appearance of the patient, the absence of any enlargement of the lymphatic glands, and the small amount of induration at the edges of the sore.

Pathology.—Sections of the margin of a rodent ulcer show the typical structure of a carcinoma ; that is, epithelial cells in an alveolar fibrous stroma. The cells are arranged in columns which penetrate into the neighbouring structures, as in the case of squamous epithelioma. But the cells of a rodent ulcer are not squamous epithelium. They are much smaller, rounded or angular in shape, often with spindle-shaped nuclei. Neither does the rodent ulcer take its origin from the surface epithelium, though the place from which it does arise is still the subject of a difference of opinion. Some believe that it takes its origin from the sebaceous glands ; others from the hair follicles ; and again others from the sweat glands.

Treatment.—When a rodent ulcer is confined to the soft parts, the best treatment is its free removal with a considerable margin of apparently healthy skin around, and then covering the rawed surface by means of Thiersch's skin grafting. If the disease is by this means thoroughly removed, a successful result may be anticipated, and there will be no recurrence. But it must be borne in mind that nothing but a very free removal of the tissues in the neighbourhood of the ulcer will effect this object. If the deeper structures, especially the bones, have become implicated, the outlook is not so promising ; and in addition to the free removal with the knife, the whole of the rawed surface should be covered with a thin layer of Vienna paste, made by mixing one part of chloride of zinc with two of flour and mixing into a paste with water. This caustic is preferable to fuming nitric acid or potassa fusa, which are sometimes recommended. The paste should be left on for two or three hours and then removed, and a boric acid poultice applied. As the application is very painful, a full hypodermic injection of morphia should be given before the patient recovers from the anæsthetic.

Perforating Ulcer.—By the generic term *perforating ulcer* is meant a peculiar, burrowing ulceration, which attacks the foot, most commonly of patients who are the subjects of locomotor ataxy, but also not unfrequently occurring in diabetic individuals, and in those who are the subjects of neuritis arising from any cause. Patients who have a spina bifida occulta are also sometimes the victims of this condition.

The disease commences as a small round sore, presenting the appearance of an ordinary pressure ulcer, usually on the sole, and more particularly under the heads of the metatarsal bones. As the disease extends, the ulcer burrows upwards through the soft parts, until it reaches the metatarsal bones, which then become implicated and the seat of a rarefying ostitis. The metatarso-phalangeal joint often becomes involved, and a suppurative arthritis set up. The ulcer now presents the appearance of a funnel-shaped sinus, surrounded by unhealthy-looking granulations and discharging a foul-smelling pus. Upon introducing a probe, rough bare bone will be felt, and grating upon moving the joint surfaces on each other will be detected. There is usually little pain, and the skin around, in many cases, entirely loses its sensibility and becomes anæsthetic. There is often profuse sweating of the foot.

Combined with this will be the evidence of the condition which has given rise to the disease; the symptoms of locomotor ataxy in the tabetic patient; the presence of sugar in the urine in the diabetic patient; and the presence of the tuft of hair in the lumbo-sacral region, so characteristic of spina bifida occulta.

Treatment.—A perforating ulcer can generally be healed by enforcing strict rest and preventing the patient putting his foot to the ground, combined with strict cleanliness, and where the bone is carious, cleaning the diseased tissue away with a sharp spoon. But unfortunately, though the perforating ulcer can be cured in this way, it is very liable to recur as soon as the patient begins to get about again. In treating these cases it is right in the first place to endeavour to heal the ulcer by the measures indicated, and then to try and prevent its recurrence by inserting a thick felt sole into the boot, with a hole in it corresponding to the site of the ulcer, with a view to relieving pressure. Should the ulceration recur, the only remedy is amputation.

DISEASES OF THE NAILS

Onychia is a disease of the nails dependent on inflammation of the matrix. It is usually described as occurring under two forms, onychia simplex and onychia maligna; but it seems simpler to describe them as one, and regard the two conditions as different varieties of the same disease. The inflammation is of an unhealthy character, and goes on to ulceration; the nail becomes shrivelled and thrown off, leaving a foul ulcerated surface, which discharges fœtid, sanious pus. The disease usually occurs in tuberculous children, originating in a crush of the end of the finger or toe; or it may occur in syphilitic individuals, and is said by some to be also due to the inoculation of the parasite of ringworm under the nail, from the child affected with this disorder scratching his head. In the simple form there is redness, heat, and swelling generally on one side of the nail, which becomes black, loosened, and thrown off, leaving an ulcerated surface, over which a deformed and thickened nail gradually forms. In onychia maligna the disease begins in the same way; the nail becomes shrivelled, black, and loosened, and eventually separated, leaving a foul excavated ulcer, exuding a fœtid discharge. This ulcer shows little tendency to heal if untreated, and may spread until the bone becomes exposed and necrosed, or the neighbouring joint opened.

Treatment.—If the nail has not separated, it should be removed and the part dressed with iodoform. If there is any suspicion of its being syphilitic, black wash applied locally and the usual constitutional treatment for syphilis is indicated. In many cases scraping the surface of the sore will expedite the cure.

Ingrowing of the Nail.—This is an exceedingly painful affection arising from wearing pointed boots, so that the toes are squeezed together, and the outer edge of the nail, generally of the great toe, is pressed into the skin and causes ulceration, which leads to the formation of large painful granulations, which discharge fœtid, sanious pus, and prevent the patient taking any active exercise.

Treatment.—In the early stages, before ulceration has occurred, relief may be given by removing all pressure by the use of proper boots and filing down the nail along its centre until it is quite thin. After ulceration has taken place, the only plan which affords real and permanent relief is to remove the nail, and even after this it not unfrequently happens that the condition recurs; therefore at the same time that the nail is removed a wedge-shaped piece of the skin over the pulp of the toe should be removed and the edges brought together. This simple little operation may be performed in the following manner. After the nail has been removed by slitting it down the centre with a pair of scissors and tearing out each half with avulsion forceps, a semicircular incision is made around the end of the toe from a point corresponding to where the nail joins the skin on the dorsum and about half an inch below the level of the nail to a corresponding point on the opposite side (fig. 75). A second incision is then made of corresponding length starting from the same point, but carried round the end of the toe about a third of an inch below it; the piece of skin included between these incisions with a wedge-shaped mass of the subcutaneous tissues is removed, and the two edges sutured together with a continuous horsehair suture. The wound will heal in a week or ten days, and no recurrence of the disease is to be anticipated.

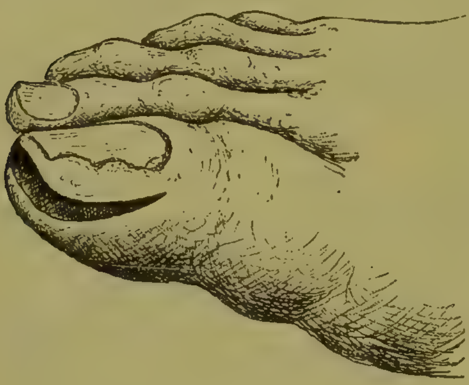

FIG. 75.—Operation for the cure of ingrowing toe-nail.

CHAPTER II

INJURIES AND DISEASES OF VESSELS

Injuries of Arteries.—The injuries of arteries may be classified in the following manner: (1) Contusion; (2) Subcutaneous laceration, which may be partial or complete; (3) Division, which may also be partial or complete.

1. **Contusion.**—Little is definitely known about contusion or bruising of the coats of an artery; but cases have been recorded in which after a blow or crush an artery has become slowly and completely occluded by clot. This is believed to be due to some change in the endothelium, as the result of the injury, which causes the leucocytes to adhere to the wall of the vessel; they then disintegrate, and setting free the fibrin ferment, the formation of a thrombus is the result. In other cases bruising of an artery may be followed by contraction and permanent diminution in the size of the vessel. Both these conditions may lead to gangrene. The injury is rarely uncomplicated, nor can the exact condition of the artery be diagnosed.

2. **Subcutaneous Laceration.** — The coats of an artery may be torn by a blow, crush, or strain, or by a stab with a blunt instrument, as the horn of a bull, or by a spent bullet, and the tear may involve only the two internal coats of the vessel (partial laceration) or all the coats may be torn (complete laceration).

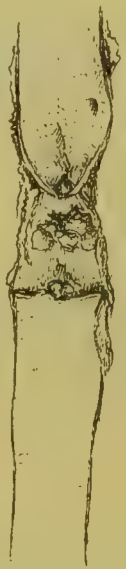

FIG. 76.—Partial laceration of an artery. A portion of the axillary artery, showing laceration of its two internal coats, which have become separated from the external coat and turned inwards into the cavity of the vessel, so as to block it up. (From a preparation in the Museum of St. George's Hospital.)

Partial laceration consists in the tearing of the internal and middle coats, while the external coat remains entire. The internal and middle coats of an artery are very brittle, and liable to give way from external violence which is not severe enough to tear the tough external coat. Under these circumstances the two internal coats, being ruptured by a crushing, twisting force, are separated from the external coat to a considerable extent, and, being highly elastic, curl up in the interior of the vessel, and partially or completely occlude it, leaving the external coat of the vessel exposed (fig. 76). At the injured spot coagulation takes place, and a thrombus is formed, which further occludes the vessel, and gangrene of the parts supplied by the artery may result. Generally, however, the collateral circulation is sufficient to maintain the vitality of the part, if the accompanying vein is uninjured. The exposed part of the external coat may subsequently give way, and a traumatic aneurism may form. The nature of the injury is generally plainly indicated. After some injury over the region of an artery, the parts below become pale and bloodless, all pulsation is absent in the vessels below the seat of injury, whilst the artery above this point can be felt to beat strongly, and the pulsation to cease abruptly at the seat of injury. There may or may not be superficial bruising. The treatment consists in endeavouring to maintain the vitality of the part by warmth, rest, with slight elevation to promote venous return, and protection from pressure or constriction. Should gangrene supervene, amputation must be performed.

Complete subcutaneous laceration.—This is most commonly met with in the popliteal and axillary arteries, and is especially apt to occur in strains upon diseased vessels; as, for example, in an attempt to reduce an old dislocation of the shoulder, and in an injury to the lower extremity producing hyper-extension of the knee. When a large vessel like these is ruptured, enormous extravasation of blood takes place in most cases: swelling and discolouration of the limb result, with a cessation of pulsation in the vessels below and a rapid fall of temperature, and gangrene rapidly ensues. In some cases, probably owing to the curling inwards of the inner coats and the dragging down and twisting of the external coat, little or no blood is lost, yet gangrene is very likely to set in, though not so rapidly. Again, in other cases the artery may not be completely torn across, though a large laceration has been made in it. In these cases a certain amount of pulsation may be perceptible in the vessels below, and gangrene may be long delayed or may not occur at all.

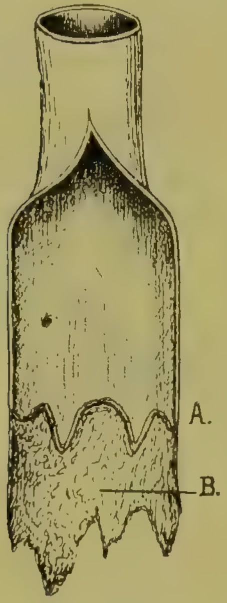

FIG. 77.—Complete rupture of an artery. The internal and middle coats of the vessel have been torn at a much higher level (A) than the external coat B. Diagrammatic.

Treatment. — In cases of subcutaneous laceration of the main artery of a limb, the treatment must vary according to the amount of extravasation of blood which has taken place. If there is little or no extravasation, efforts should be made to preserve the vitality of the limb by warmth, position, rest, &c., and if gangrene ensues amputation must be at once resorted to. If, on the other hand, extravasation has taken place, an incision must be made to turn out the clots, which would otherwise press on the smaller vessels of the limb and prevent the collateral circulation being established. After turning out the clots, the ruptured vessel should be sought for and both ends ligatured. In almost all cases, especially in the lower limb, gangrene ensues, and then amputation must be immediately resorted to.

The laceration of an artery in an open wound, as when a limb is torn off by machinery, does not as a rule cause much hæmorrhage; and this is on account of the brittleness of the inner and middle coats and the toughness of the outer one. The two inner coats are rapidly torn across on the first application of the violence and curl up in the vessel, while the external coat, on account of its toughness, resists the force for a longer time, and is pulled down and twisted over the curled-up inner and middle coats so as to completely occlude the orifice (fig. 77).

3. **Division of an artery** with some cutting instrument may be complete or incomplete.

Incomplete division.—The term incomplete division is applied to two very different conditions. (1) The one is not of much importance, as it rarely occurs, and when it does must be regarded and treated exactly in the same way as a wound penetrating the vessel. The term is applied to those rare cases where the external coat is divided by a knife or sharp instrument which does not completely penetrate through all the coats. As, however, the uninjured coats will in all probability eventually give way, the vessel should be ligatured above and below the injured spot.

(2) The other way in which the term incomplete division of an artery is applied is where the vessel is only partially cut across and not completely divided, and these cases are of great practical importance, since the artery is unable to contract and retract in the same way that a severed artery can do, and thus the bleeding continues. The treatment in these cases consists in converting the incomplete into a complete division. To this class of cases belong the *punctured* wounds of arteries. These may be produced by stabs, or by pins or needles, or by sharp fragments of bone from a fracture. If the wound is produced by a fine, aseptic needle, no hæmorrhage may ensue or evil effects be produced ; the elasticity of the coats at once closing the puncture. But if the wound is larger, then there is hæmorrhage ; and as these wounds are often oblique, the blood does not escape through the external wound, and a traumatic aneurism may result. When the wound in the artery is large, it will go on bleeding until some efficient obstacle to the further flow is established. This may be a natural arrest by the formation of a clot in the tissues around which presses upon and occludes the orifice of the vessel, or it may be an artificial arrest by the pad and bandage or ligature of the surgeon. The amount of hæmorrhage will vary with the direction of the wound ; a longitudinal wound will bleed less than a transverse one, because the latter gapes more. The only safe treatment of an incomplete wound of an artery is to convert it into a complete one, and tie the vessel above and below the division.

Complete division of an artery.—When an artery is completely cut across, free hæmorrhage is the result. If the artery is of any considerable size, the case is rapidly fatal ; if the vessel is of smaller size, faintness may be induced, and coagulation take place in and around the cut end of the vessel, and the case may not prove fatal. This will be again alluded to in speaking of the natural arrest of hæmorrhage. The treatment consists in tying or twisting both ends of the divided vessel.

Injuries of Veins.—Veins, like arteries, may be contused, lacerated, or cut.

Contusion of veins may lead to alterations in their coats and the formation of a thrombus, which will occlude the vessel, or if more severe may lead to death of the portion of the vein which has been injured.

Laceration or **rupture** of a vein may occur in the same way as laceration of an artery ; in fact, the two vessels may be torn at the same time by the same cause. More extensive hæmorrhage usually takes place in cases of laceration of a vein than when an artery is torn, on account of the small amount of muscular and elastic tissue which the walls of a vein contain. Hence it follows that a fatal issue may result from a subcutaneous laceration of a large vein; or, if this does not occur, the amount of extravasated blood is so great that it presses on the vessels by which the collateral circulation should be carried on and produces gangrene. In certain situations, where the veins are contained in rigid canals, as the hepatic veins and the sinuses of the cranium, no collapse can take place, and here death from hæmorrhage may occur, even though the vessel injured is of no very great size.

Wounds.—When a wound of one of the large veins, such as the femoral or internal jugular, is inflicted, it rapidly proves fatal, unless prompt measures are taken to arrest the bleeding. This can generally be done by external pressure, on account of the thinner coats and the lower pressure of blood in the veins. In punctured and small incised wounds, especially if made in the long axis of the vessel, the lips of the wound come together and unite without obliteration of the lumen of the vessel if pressure is applied. This was commonly the case in former days, when venesection was constantly practised—a patient was often bled many times from the same vein. When a vein is completely cut across, it collapses as far as the nearest set of valves, and becomes permanently occluded up to the first collateral branch.

Treatment.—When possible it is desirable to get wounds in veins to heal without obliterating their lumen. Punctures in large veins should therefore be treated by picking up the wall of the vein around the puncture and tying it by a lateral ligature. A large wound, however, requires ligature of the vein in two places and division of the vessel between the ligatures. When a large external vein is wounded it was formerly recommended that the accompanying artery should also be ligatured, in order to prevent the occurrence of moist gangrene; but this is now believed not to be desirable, as it is more likely to lead to gangrene than if the artery is left alone. When, however, both vessels are wounded, both must be tied.

Wounds of veins are dangerous, not only on account of hæmorrhage, but also from the risk of septic or spreading inflammation, which will be considered in the sequel; and in certain regions from the risk of the entrance of air into the lumen of the tube.

Entrance of air into veins.—This is a rare accident, and almost unknown since the introduction of anæsthetics. It generally occurs during operations at the root of the neck or in the axilla, in what is known as the 'dangerous area;' that is, in that part of the venous system where, in consequence of the tendency to the formation of a vacuum in the chest during inspiration, there is a suction action in the large veins in or near the thoracic cavity. If a large vein is opened in this situation and the opening kept patent, air is sucked into the vein and is carried to the right side of the heart, where it produces very definite and serious symptoms: or if admitted in large quantities, instant death. Three things are therefore necessary for the occurrence of this phenomenon: (1) A wound of a vein in the dangerous area; (2) The patency of the wounded vein; (3) The aspiration of the thorax. There are several causes which may lead to the patency of the wounded vein, which under ordinary circumstances would collapse. It may be caused by thickening of its coats by inflammation, which prevents its collapsing; or by induration of its sheath and surrounding tissues, which keeps it open; or it may be kept agape by the contraction of neighbouring muscles, as the platysma in the neck; or by the hand of the surgeon. This latter is especially likely to occur if a vein happens to be partially divided in the angle of a wound. If the edges of the wound are held apart, the edges of the opening in the vein are stretched wide open. It may also occur in removing a tumour, the parts being held on the stretch as they are divided.

If a large quantity of air is sucked in, it may cause instant paralysis of the heart and sudden death, but generally the quantity is less, and passing to the right side of the heart it is churned up with the blood in the cavities into a frothy fluid, which cannot be forced through the pulmonary capillaries, hence there is deficient supply of blood to the brain, and syncope, which may or may not be fatal. In addition to this, the frothy fluid, being much lighter than blood, has not power to close the flaps of the valves, and the action of the heart may altogether be arrested from this cause.

Symptoms.—At the moment of the introduction of the air into the vein a sudden hissing sound is heard and bubbles of air appear about the wound. The patient becomes suddenly pale and the pupils dilate. The heart's action is turbulent, and on listening over it a peculiar churning sound can be heard. The pulse is scarcely perceptible. The air can be heard entering the lungs freely. Death may take place in a few minutes or may be delayed for a longer period. If the patient recovers from the immediate danger, there is a risk of subsequent pneumonia or bronchitis.

Treatment.—The obvious thing to do in the first instance is to prevent the entrance of any more air into the vein. This is to be done by compressing the wounded vein with the finger, and if possible applying a ligature, or, what is more convenient and speedy, a pair of forcipressure forceps on the cardiac side of the wound. Then every effort should be made to keep up the supply of blood to the brain. This is to be done by maintaining the body in the recumbent position, with the head hanging over the end of the table, and compressing the abdominal aorta and the two subclavian arteries, so that all the blood circulating may be diverted from the extremities. At the same time the action of the heart must be maintained by stimulants, ammonia to the nostrils, the subcutaneous injection of ether, enemata of hot brandy and water, and galvanism to the præcordial region.

HÆMORRHAGE

Hæmorrhage is the natural consequence of wounds of vessels, whether inflicted accidentally or by the surgeon's knife, and may vary in amount, according to the nature of the lesion, from a few drops to sufficient to cause the death of the patient. When occurring suddenly and in large quantities it taxes, more than anything else, the courage and resources of the surgeon, and therefore its full consideration forms a most important part of practical surgery.

The character of the hæmorrhage differs according to the nature of the vessel which has been wounded, whether artery, vein, or capillaries. It is necessary, therefore, to distinguish these varieties. In *arterial* hæmorrhage the blood is of a bright scarlet colour, and is expelled in a forcible stream in jerks, which are synchronous with the systole of the heart; between the jerks the stream does not cease, but is propelled less forcibly. As the bleeding continues the column of blood falls in height and becomes less forcible, until at last it simply trickles from the wound. The height and force of the jet depend, of course, on the size of the vessel. The student should bear in mind that there are exceptions to these characters of arterial hæmorrhage. When a patient is asphyxiated the blood from an artery is not scarlet, but of a purplish black colour. This is often seen in operations where the anæsthetic employed is ether. Again, if the wound is a punctured one and the blood has to find an exit along a sinuous tract, it loses its jetting character and simply wells from the wound. In *venous* hæmorrhage the blood is of a dark purple-red colour. It is, like arterial hæmorrhage, expelled in a stream, but the stream forms one continuous jet, which is uninfluenced by the contraction of the ventricles. The blood comes from the distal end of the vein. In capillary hæmorrhage the blood, which is bright in colour, oozes from the whole surface of the wound, and collecting in its deeper parts forms a pool of blood.

The **effects** produced by hæmorrhage depend principally upon the amount of blood lost and the rapidity with which it is shed; but the age, sex, and constitutional condition of the patient may be said to have some influence on the effect produced. Children as a rule bear loss of blood very badly; a comparatively small loss of blood in an infant, as, for instance, that which attends an operation for a complicated case of hare-lip, is often followed by very considerable collapse, and a still greater loss may be followed by fatal syncope. If, however, they recover from the immediate effects, they quickly recover from the resulting anæmia. Aged people also bear loss of blood very badly, and, unlike children, the convalescence is very slow, and a severe loss of blood in an old person may be followed by permanent ill effects, and he may fall into a condition of anæmia, from which perhaps he may never recover, or which may cause the development of some secondary disease. I think there can be no question that women not only bear loss of blood better than men, but their rallying powers afterwards are much greater than those of the male sex. Some people are said to bear loss of blood worse than others; this may be due to some constitutional peculiarity, or may be due to the presence of some organic disease: patients, for instance, suffering from albuminuria bear loss of blood badly. When a large quantity of blood is suddenly lost, from the wound of one of the largest vessels, the patient dies in a few seconds. He becomes intensely pallid, falls fainting, makes a few convulsive movements and expires.

When a less amount of blood is lost, the face and general surface of the body become blanched and cold, and the lips and mucous surfaces pallid. The pulse becomes increasingly rapid, small, and weak. The breathing is hurried, gasping, and there is a sense of want of breath. There is constant restlessness, the patient turning himself on the bed and throwing his arms and his legs about; and sometimes convulsions occur, especially in children. The body becomes covered with a cold and clammy sweat. Dimness of vision and deafness, with singing noises in the ears, nausea and faintness, are complained of. After a time unconsciousness from syncope supervenes, and then the bleeding usually stops; or, on the other hand, if the bleeding does not stop, the patient dies. After death the body is shrunken, white, or waxlike in appearance, and all the internal organs are pale and bloodless.

In other cases of hæmorrhage, if the bleeding is not from so large a vessel it stops after a time, probably when syncope supervenes, and may then recur. In this way the body becomes more gradually drained of blood, and shrunken from the absorption of fluid from the tissues. The blood becomes so fluid that serum filters through the walls of the capillaries and collects in the perivascular spaces, producing œdema, which is especially marked in the lower extremities. The pulse is very feeble and rapid, soft from want of tone, and often dicrotic. There is great anæmia, the skin being of a yellowish white tint; the temperature is subnormal. The patient complains of great thirst, and is liable to faint, especially on each return of the hæmorrhage. In cases which do not terminate fatally, the early period of recovery may be marked by a certain amount of febrile reaction. The temperature is raised: the pulse beats rapidly, but is weak, small, and easily compressed: there is often vomiting, and the patient complains of feeling weak and languid.

When a surgeon is confronted by a case of hæmorrhage, his first care must be to arrest the bleeding, by methods which will be mentioned in the sequel. The constitutional treatment of the patient will then have to be undertaken, and this will vary with the amount of blood lost. If this has not been excessive, and there is no fear of fatal syncope, the treatment is sufficiently simple. The patient must be kept absolutely quiet, with his head low, and free from any external source of annoyance. He should be wrapped in a warm blanket, with hot-water bottles in the bed. If he can swallow and there is no nausea, a little hot beef tea should be given by the mouth, and if the pulse does not improve a little hot brandy and water; or if he cannot swallow, a small quantity of hot brandy and water should be injected into the rectum. If, on the other hand, there are symptoms which indicate danger of fatal syncope, more vigorous measures must be adopted to prevent it. The patient should be laid flat on his back, with the head as low as the body. Too many persons should not collect round him, so as not to interfere with the free access of air. Cloths wrung out of boiling water should be applied to the head, and sinapisms to the præcordial region. The subcutaneous injection of ether (ʒss to ʒi) should be resorted to, and in doing this the needle of the syringe should be pushed deeply into the tissues, preferably the great gluteal muscle, as when injected superficially it is liable to produce great irritation and even sloughing of the tissues into which it is introduced. Enemata of hot brandy and water should be given, and in very severe cases it may be advisable to compress the abdominal aorta and subclavian arteries, so as to confine the blood as much as possible to the head and trunk. If death appears imminent recourse may be had to transfusion or the injection of a saline solution into the veins, or, what in my experience has proved equally efficacious, the injection of a couple or three pints of normal saline solution (ʒj of common salt to a pint of water) at a temperature of 105° F. into the rectum. This has seemed to me to act quite as well as the injection of the solution into the veins; it is rapidly absorbed, and can be much more quickly done than the other operation.

Transfusion.—The operation of transfusion, that is to say, the transference of the blood of another person into the circulation of the patient, has now been practically abandoned, for, as Dr. William Hunter has shown, the immediate danger of loss of blood arises from a sudden fall in the blood pressure, and an ordinary saline solution answers the purpose of restoring the blood pressure equally as well as blood. It seems, therefore, scarcely necessary to describe the operation. Great care is required to prevent the introduction of any coagulum, and probably the apparatus introduced by Aveling is the simplest and best for performing it.

Intra-venous injection of a saline fluid yields just as good results as the transfusion of blood; it is much simpler; does away with the risk of embolism, and therefore should always be preferred. The operation may be performed with a normal saline solution (ʒj of sodium chloride to one pint of boiled distilled water), or the following solution may be used: Sodium chloride, gr. L; potassium chloride, gr. iii; sodium sulphate and sodium carbonate, of each gr. xxv; sodium phosphate, gr. ij in a pint of boiled distilled water. The operation must be done with antiseptic precautions. The largest vein at the bend of the patient's elbow is exposed and ligatured at the lower extremity of the incision. It is then seized above the ligature with a pair of fine dissecting forceps, and an oblique cut made into it with a pair of scissors, dividing it about halfway across. By retaining hold of the triangular flap thus made with the forceps, a glass cannula, which should be slightly bent, can easily be introduced into the vein and tied in (fig. 78). To the cannula should be attached a short piece of india-rubber tubing, to the other end of which a funnel is connected, into which the fluid can be poured, with the funnel held at a sufficient altitude to insure its admission into the vein (fig. 79). The solution should be of a temperature of 105° F. and at least a pint and a half or two pints must be injected. Sometimes a still greater quantity is required, the surgeon being guided by the effect produced and the condition of the pulse. Great care must be exercised to prevent the introduction of any air into the vein by filling the tube and cannula with fluid before its introduction.

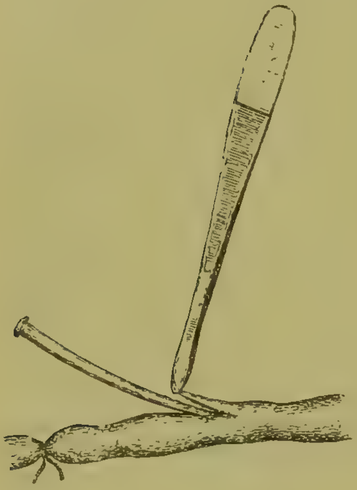

FIG. 78.—Intra-venous injection. Diagram to show the manner in which the vein is to be opened and the cannula introduced.

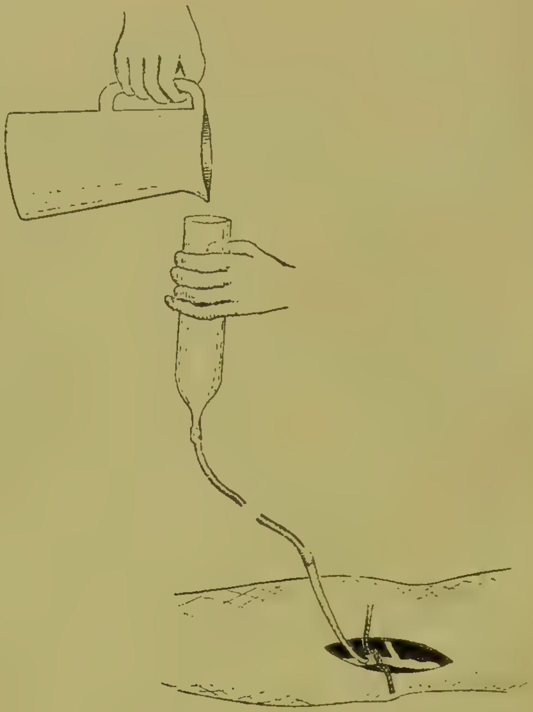

FIG. 79.—Diagram showing the mode in which the fluid is introduced into the vein in intravenous injection.

ARREST OF HÆMORRHAGE

Natural arrest of hæmorrhage.—If an artery below a certain size is cut across, the bleeding, after a longer or shorter time, will cease spontaneously, and the patient will not bleed to death. Even in arteries of the size of the radial at the wrist, or the facial, in many cases the vis medicatrix naturæ will be sufficient to stay the hæmorrhage. This arrest of bleeding is brought about by coagulation occurring in and around the cut end of the vessel. When an artery is cut across it retracts within its sheath, in consequence of the fact that it is elastic and to a certain extent on the stretch, so that the blood after it escapes from the cut end of the vessel has to pass over the rough and uneven internal surface of the sheath from which the vessel has retracted, before it escapes through the wound in the sheath. Here it coagulates and forms a clot, which, though lying within the sheath, is external to the artery. This is known as the *external coagulum.* The blood being prevented from escaping from the cut vessel by this clot which has formed external to it, but within the sheath, now coagulates within the vessel up to the first collateral branch. This constitutes the *internal coagulum*, and by the formation of these two clots, the one inside the vessel and the other outside, all further bleeding is stayed and temporary arrest of hæmorrhage is said to have taken place (fig. 80). In the production of this temporary arrest, the external coagulum is undoubtedly the most important factor, for with regard to the internal one it might happen that the division of the artery had taken place just below a large collateral branch, and then there would be no room for an internal clot to form. The internal clot is conical in form, and its base at the open end of the vessel is continuous with the external coagulum.

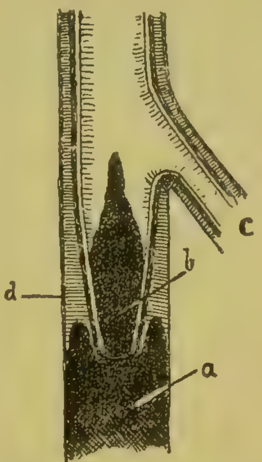

FIG. 80.—Temporary natural arrest of hæmorrhage. *a*, external coagulum ; *b*, internal coagulum ; *c*, first collateral branch ; *d*, sheath of vessel.

The causes which conduce to this coagulation are several. (1) Not only does the cut end of the artery retract by virtue of its elasticity, but it also contracts from the action of the muscular fibre cells of the middle coat, so that the orifice through which the blood escapes is materially narrowed, and this forms an impediment to the flow of blood and serves to check it. So great is this contraction that in the smaller vessels, which contain a large amount of muscular fibre, it is sufficient to completely close the orifice ; but in the larger arteries, which contain less muscular and more elastic tissue, this is not so, it merely diminishes the aperture in the artery. (2) The loss of blood after a time lessens the force of the heart's action, so that the blood is propelled with less force through the diminished orifice. We have already seen that hæmorrhage generally ceases when the patient faints ; this is no doubt due to the weakened force of the heart's action, and syncope must be looked upon as a means by which nature arrests hæmorrhage, and should not therefore be too speedily counteracted by the administration of stimulants, &c. (3) The passage of the blood over the roughened internal surface of the sheath from which the artery has retracted assists in promoting the coagulation of the blood. We have already noticed, in speaking of stasis in inflammation, that there is an inherent tendency in the leucocytes to adhere to any foreign substance with which they are brought in contact; that is to say, any substance other than the healthy lining membrane of a vessel. When, therefore, they leave a wounded artery and flow over the roughened sheath —a foreign substance—they tend to adhere to it, and after adhesion has taken place they disintegrate and thus set free the fibrin ferment they contain. This ferment, acting on the fibrinogen of the blood flowing from the vessel, causes coagulation, and successive layers of clot are formed on the internal surface of the sheath until an external coagulum is formed.

This, then, constitutes the temporary natural arrest of hæmorrhage from a divided artery, and after it has taken place the process of permanent occlusion commences.

The manner in which permanent occlusion of the artery is brought about is identical with the process of healing by blood clot, which has already been described (see page 56). The clot, which, as we have seen, played an important part in the temporary arrest of the hæmorrhage, plays a very secondary rôle in the permanent arrest, merely acting as a scaffolding on which the permanent plug is built up, and at the same time no doubt acting as a pabulum for the cells from which this permanent plug is developed. The first change which takes place is that the temporary clot, like all other clots after formation, contracts, and serum exudes from it. The internal clot becomes more closely applied to the inner surface of the artery from the contraction of the coats of the vessel upon it; the greater part of the external clot disappears, probably washed away by the serous exudation from the wound; what remains becomes infiltrated with leucocytes, which wander into it from the vasa vasorum of the injured artery and its sheath, in which inflammatory processes have been set up as the result of the injury. Probably these leucocytes take no part in the construction of the new material which is to seal the vessel, but merely act here, as elsewhere, as scavengers. In a short time, within twenty hours according to Ballance and Edmunds, rapid proliferation of the endothelial cells of the lining membrane takes place, and probably of the other connective cells of the wall of the artery. The plasma cells permeate the clot, entering it by minute fissures or channels, which are formed in the clot in its process of contraction. These cells rapidly multiply, and undergo development into fibre cells and cicatricial tissue, and as they do so, absorb and replace the clot which, up to now, has been forming a supporting framework for them. So that what was clot is now connective tissue, which has become vascularised by the formation of channels in the fissures of the clot, which are lined with endothelial cells, and connected with the vasa vasorum of the vessel. While this has been going on, the muscle fibre cells in the wall of the artery have gradually disappeared, and nothing remains but a fibrous cord, formed partly of the remains of the coats of the vessel, and partly of the newly formed fibrous tissue, and this may finally become lost in the cicatricial tissue of the external wound. The changes above described take place both in the proximal and distal ends of a divided artery, but the clot formed in the distal end is usually small, and the various changes which terminate in complete occlusion go on more slowly and less perfectly than in the proximal end; this may probably be due to the fact that the circulation through the vasa vasorum in the distal end has been interfered with by the division of the artery.

In cases where an artery is partially divided, the method of repair is somewhat different. The temporary clot is formed by blood becoming extravasated into the sheath around the wound in the artery ; this blood coagulates, presses on the wound in the vessel and occludes it, and arrests the flow of blood. A small layer of clot also forms internally over the inner surface of the wound, and if this is small may act as a framework in which connective tissue is formed by proliferation of the endothelial cells, and a cicatrix is formed in the wall of the vessel without obliterating it. When this occurs, the scar, being exposed to the full force of the blood pressure whilst it is yet immature, is liable to yield, and to form an aneurism. What generally happens is that the clot which forms inside the vessel goes on increasing, until it occludes it, opposite the seat of injury, and when this occurs, the formation of the vascular connective tissue is precisely the same as in a divided artery, and the vessel at this point becomes converted into a fibro-cellular cord. This is not, however, the case with a partially divided vein ; here there is not the same tendency to obliteration of the vessel, but the wound heals without closure of the tube. When a vein is divided completely across, the permanent healing is identically the same as occurs in an artery.

Surgical means of arresting hæmorrhage.—When a surgeon is called to a case of hæmorrhage, his first care must be to temporarily arrest the flow of blood. When there is an open wound, and the bleeding comes from a definite point, as when one large vessel is wounded, this can be done by pressure, with a finger on the spot. But if the bleeding does not come from a definite point, and seems to well up from the deeper parts of the wound, a soft sponge introduced and maintained in the wound by the firm pressure of the hand will momentarily restrain the hæmorrhage until further measures can be taken. If the bleeding is at all free, it is better to apply a tourniquet, if the wound is in one of the extremities, or to get an assistant to compress the main artery on the cardiac side of the wound, while preparations are being made to apply means for permanently arresting the bleeding. These means we have now to consider. They are numerous, and may be tabulated as follows : (1) application of cold ; (2) application of heat ; (3) styptics ; (4) actual cautery ; (5) pressure ; (6) forcipressure ; (7) acupressure ; (8) flexion ; (9) torsion ; (10) ligature.

1. **Application of cold.**—The application of cold is a useful means of arresting general oozing from a wound. It acts by causing contraction of the muscular coat of the blood-vessels, and therefore is of no avail in cases where they are partially divided. It may be applied in several ways. The exposure of a wound to a draught of cold air will sometimes arrest the bleeding. For instance, after excision of a tonsil, if the bleeding is free, placing the patient before an open window with his mouth wide open will often arrest hæmorrhage, which while the mouth was shut showed no inclination to stop. A stream of cold water played over a wound will often cause all bleeding to cease ; or if this does not succeed, the application of ice may prove efficient. This latter plan of treatment should not, however, be continued too long, for fear of gangrene.

2. The **application of heat** is a far more useful and valuable means of arresting hæmorrhage than cold, as its effects are much more permanent. It acts in the same way by causing contraction of the

muscular coat of the vessel, but to do this it must be of a temperature of at least 115° F. and preferably a little higher than this, somewhere between 120° and 140°. If it is more than this it will char the tissues and prevent primary union; if it is less it will be worse than useless, as it encourages the bleeding, and washes away any coagula which may have already been formed in the vessels. The application of sublimate solution (1 in 4,000) or carbolic acid solution (1 in 40) at this temperature will be found a most efficient means of checking the general oozing in a large operation wound, such as excision of the breast, or amputation of one of the extremities. It is also exceedingly useful in stopping bleeding from very vascular parts, as the face, the genital organs, and inflamed bone. Irrigation with hot water is also serviceable in arresting hæmorrhage from bleeding cavities, as the uterus, &c.

3. **Styptics** are chemical substances which, acting on the blood, cause its coagulation. They can only be of use in arresting hæmorrhage when they cause coagulation of the blood in the mouth of the injured vessel, when in fact they bring about a process identical to what has already been described as 'temporary arrest' of hæmorrhage. If, therefore, they merely coagulate the blood lying on the surface of the wound, they do very little good, as bleeding can take place from the unsealed vessels under the clot thus formed. In order, therefore, to obtain arrest of hæmorrhage by means of styptics, they must be applied with care. The wound should be first thoroughly dried, and all coagula removed. Firm pressure with a sponge should be maintained over the bleeding point, and a piece of lint soaked with the styptic immediately placed on the part as soon as the sponge is removed, and held there for a minute or two until coagulation *in* the vessel has taken place. The principal styptics used in surgery are perchloride of iron, nitrate of silver, alum, tannin, gallic acid, matico leaves, and turpentine. Of these, perchloride of iron in the form of the strong liquor is the most efficient. The objection to their use is that they are apt to cause destruction of the tissues with which they are brought into contact, and thus interfere with union by the first intention. Their use is, therefore, almost limited to bleeding from mucous cavities, where less stringent measures have failed to arrest the hæmorrhage. They are, however, of especial use in bleeding from fungating malignant tumours, and are the most efficient agents we possess for arresting hæmorrhage of this kind.

4. **Actual cautery** is a most powerful hæmostatic, and will arrest hæmorrhage from an artery the size of the anterior or posterior tibial, but it is little used in the present day, as it burns the tissues and causes a slough, which prevents primary union and renders the patient liable to secondary hæmorrhage upon its separation. It acts by charring the end of the artery and forming an eschar over its mouth, and also causes the vessel to contract and fold upon itself, and thus to plug the lumen of the tube and arrest the flow of blood. It may be used either as a cautery iron, which can be heated in the fire to a dull red heat, or by means of Paquelin's cautery, which is perhaps the most convenient and handy form to use, or by means of the galvano-cautery. Whichever form is used, it should not be applied until the dull red colour is changing to black, when it should be placed accurately on the bleeding spot and held in apposition for a few moments. If a greater heat is used, it burns the tissues without charring them, and does not act as an hæmostatic. This plan of checking hæmorrhage is principally of use in bleeding from soft spongy tissues

which will not bear a ligature. The galvano-cautery and the Paquelin's knife are still used by some in operating on very vascular parts, as in removal of the tongue, but their action is uncertain; they leave a charred surface, which has to separate by sloughing, and is very liable to be followed by secondary hæmorrhage. They are not therefore to be recommended.

5. **Pressure** is another means by which hæmorrhage may be arrested, and when employed as a temporary expedient it is a most valuable and efficient method of doing so, either by making direct pressure on the bleeding spot with a finger, or by means of a tourniquet arresting the circulation in the wounded part until some other means can be taken to secure the wounded vessel. As a permanent mode of treating hæmorrhage, pressure is also frequently useful, but requires caution in its use. The cases for which it is most applicable are the following: (1) Where the bleeding is from a superficial vein; here it can always be arrested by a compress placed over the wounded vein and bandaged in position. Much less force is required to arrest the flow of blood through a vein than an artery, and the amount of pressure employed need not be so great as to run the risk of interfering with the vitality of the parts pressed upon. (2) Where the bleeding is from a medium-sized artery, which lies on a bone and can be compressed against it without any great amount of force, as the temporal artery in the scalp. But in those cases where pressure is applied under these circumstances, care should be taken, before applying the pad, to divide the vessel completely across, if it has only been punctured, to permit of its contraction and retraction. (3) Where the bleeding is a general oozing from the surface of a wound, as after an excision of the breast, pressure is all-sufficient in restraining the hæmorrhage. After the wound is dressed and covered with a thick layer of wool, a bandage firmly applied will make uniform elastic pressure, which will arrest the bleeding without doing any harm. (4) Where the bleeding is from a cavity which can be completely filled with gauze or lint, pressure forms a convenient method of arresting hæmorrhage: thus, when a cavity is left in a bone, after removal of a sequestrum or scraping out a carious cavity, the hæmorrhage may be easily controlled by stuffing it with gauze; or bleeding after opening a cystic bronchocele or a hæmatocele in the neck may be treated in the same way. (5) Where the bleeding comes from some deep part, as the prostatic sinuses or deep perineal vessels, after perineal cystotomy, and the vessels cannot be reached to ligature, reliance must be placed on pressure to control the hæmorrhage; but in these cases pressure must be applied directly to the injured vessels to be of any avail, and not to the external wound, otherwise the blood will go on collecting in the deeper parts of the wound and will eventually displace the pad, and the bleeding will recur.

Formerly efforts were often made to control bleeding by a graduated compress placed over the bleeding point and firmly bandaged in position. For instance, in wounds of the palmar arch, the ordinary routine treatment was to place a graduated compress over the wounded vessel and then firmly bandage it there, a splint being placed on the back of the hand from which to make counter-pressure. This plan of treatment has, however, very serious drawbacks, and should never be resorted to unless circumstances render it absolutely necessary; for, in the first place, the amount of pressure necessary to restrain the hæmorrhage is often so great as to produce sloughing of the tissues upon which it presses, and when the sloughs separate, secondary hæmorrhage is the result; or, again, the bandage may be applied so tightly as to arrest the whole circulation in the part, and total gangrene of it may ensue. Again, if the apex of the graduated or conical compress is not placed directly on the wounded artery, blood will continue to escape and collect around the vessel, and this may lead to the formation of a traumatic aneurism. The practice, therefore, of attempting to arrest hæmorrhage from a wound of a large or medium-sized artery by a compress and bandage is now almost a thing of the past. Perhaps the only cases in which such a proceeding is advisable is where secondary hæmorrhage occurs after ligature of an artery in its continuity, and this is nowadays happily an accident which is almost unknown.

6. **Forcipressure.**—There are few things in the practice of modern surgery which add more to the comfort of a surgeon in operating than the invention by Spencer Wells of the 'clip forceps,' and the introduction of forcipressure. These forceps are merely ordinary dressing forceps provided with a catch, so that when a portion of tissue is seized by them they retain their hold. When an operation is to be performed, the assistant to the operator provides himself with several pairs of these clip forceps, and as soon as a vessel is cut seizes the open mouth with them, closes the catch, and allows them to remain hanging from the wound. By the time that the operation is completed, coagula will have formed in the vessels if they are not above a certain size, and the clips may then be removed and no further attention need be paid. By this means, therefore, many vessels which formerly required tying are much more simply dealt with. Should any bleeding occur on removing the forceps, as will happen in vessels of a larger size, they must be again seized and ligatured. There is another way in which these clip forceps are pre-eminently useful. It may happen occasionally that hæmorrhage may take place from a vessel at the bottom of a deep wound, which cannot easily be got at and ligatured. With a pair of clip forceps the vessel may be seized and the forceps left on, included in the dressings, for three or four days, until permanent occlusion of the vessel has taken place.

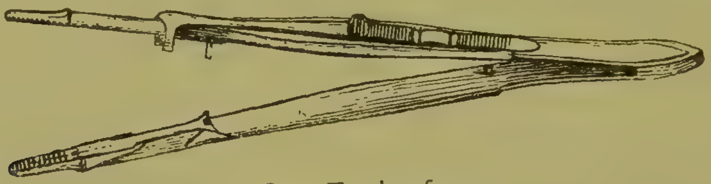

FIG. 81.—Torsion forceps.

7. **Acupressure** scarcely needs more than a passing notice, as it is rarely or never employed in the present day as a means of arresting hæmorrhage. It consists in introducing a long needle through the tissues in such a way that it shall press upon the bleeding vessel and occlude it by bridging over or twisting it. The end of the needle is left protruding on the surface of the body, so that it can be withdrawn at the end of twenty-four or forty-eight hours. This plan of treating hæmorrhage was introduced by Sir James Simpson when the old septic silk ligature was almost the only means the surgeon had of dealing with hæmorrhage from cut arteries. The end of the ligature was allowed to hang out of the wound until it came away, by cutting through the coats of the vessel it encircled, so that it acted as a sort of seton and prevented primary

union of the wound. The plan of acupressure was introduced to obviate this, but now that arteries are tied with an aseptic absorbable ligature this mode of arresting hæmorrhage has fallen into disuse.

8. **Flexion** is another plan of treating hæmorrhage, which is probably never employed in the present day. It is applicable mainly to wounds of vessels in the forearm and hand, or the leg and foot, and consists in forcibly flexing the elbow or knee joint until the pulsation in the vessels below is arrested. The process is, however, by no means certain in its results, and is extremely painful and irksome to the patient, so that cases can scarcely ever arise in which it can be desirable to resort to it.

9. **Torsion.**—There can be no question that torsion of an artery is a most efficient way of controlling hæmorrhage, and as reliable as ligaturing it. The advantage which it possesses over the ligature is that it does not leave any foreign body in the wound; but in these days of aseptic absorbable ligatures, which are cut off short, this does not count for much, whilst its disadvantages are that it requires more skill and practice than the ligature, and in unskilful hands is more likely to fail. The plan consists in seizing the vessel with a pair of specially constructed forceps (fig. 81) with broad, bluntly serrated ends, and a catch, and then twisting them round in the long axis of the vessel some six or eight times. The result of this is that the internal and middle coats are torn through at the first twist just above the point where the forceps grasp the vessel; the tough external coat is then twisted round in the form of a screw, and as it twists it the two internal coats are separated from it and twisted up into the lumen of the vessel, where they form a conical plug which completely occludes it (fig. 82); so that even if the end of the artery which is grasped by the forceps is completely twisted off, no bleeding will ensue. It is better, however, not to continue twisting until the end of the artery comes away, as this in itself forms a further protection and prevents the spiral coil from untwisting itself, as it is sometimes apt to do if the vessel has been insufficiently twisted. Two precautions require to be observed in performing this little operation. One is that the artery alone must be seized; if the surrounding tissues are grasped in the forceps with the artery, the proceeding is likely to fail, and here it is that the inexperienced hand, especially in dealing with the smaller arteries, is likely to find difficulty. The other precaution is that the whole artery must be seized, and that one blade of the forceps must not be introduced into the open end of the vessel. The operation is applicable to arteries in which the internal and middle coats are diseased; but if the vessel is adherent to its sheath, so that it cannot be separated from it and twisted within it, the proceeding is likely to fail.

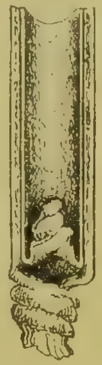

FIG. 82.
Artery closed by torsion.

10. **Ligature** is the most frequently employed and is the most reliable way of controlling hæmorrhage. It is usually applied to the cut end of the vessel in an open wound, but it is also justifiable, in certain cases, to tie the artery at some distance above the wound—as in wounds of the palmar arch. In the first place we shall consider the application of a ligature to the cut end of a vessel in an open wound, and then consider ligature of an artery in its continuity.

Before we consider the mode of applying a ligature to a cut artery and the way in which it occludes the vessel, it will be desirable to say a few words about the various materials of which ligatures are composed. The principal ligatures used by surgeons at the present day are catgut, silk, tendon, and ox-aorta; but many other materials have been advocated and used at different times, such as silver wire, silkworm gut, peritoneum, &c., but have now fallen into disuse.

Catgut is largely employed by many surgeons for the ligature of arteries in an open wound; in fact, perhaps more largely than any other material; but at the same time it must be confessed that it is not a thoroughly reliable material, as it is extremely difficult to render and keep it perfectly aseptic.

Catgut is prepared from the intestine of the sheep, from which the mucous membrane and muscular coat are removed. It is then dried and sold as commercial catgut. The removal of the mucous and muscular coats is effected by a process of scraping, and this is usually very imperfectly done, so that in the ordinary catgut of commerce remains of these coats can usually be detected by microscopic examination. It is an infective material, and has to undergo a careful preparation before it can be rendered aseptic and safe for the surgeon to use. There are several ways of doing this. Perhaps the best and simplest way of preparing it is by soaking the catgut, which should be wound loosely on a reel or some solid body to prevent it untwisting, in a solution of chromic acid of the strength of 1 in 100 for twelve hours; it is then taken out and shaken in a cloth to get rid of the greater part of the moisture, and placed in solution of one part of sulphurous acid to 100 of distilled water for another twelve hours. It is then taken out and allowed to dry on the stretch. This is known as 'green catgut.' It is kept in the dry state, and when required for use is placed in a carbolic acid solution (1 in 20) for fifteen or twenty minutes before using. Another plan is to soak the catgut for forty-eight hours in a solution of carbolic acid (1 in 20) to which chromic acid (1 in 4,000) has been added. The preparation of the catgut in this way, however, requires care, as the amount of chromic acid used must have a definite relation to the quantity of catgut to be sterilised, for if too much acid is used it will be over prepared and non-absorbent; if too little, it will be under prepared and absorbed too soon. The object of the chromic acid is to prevent the too rapid absorption of the gut. When catgut was first employed by Lord Lister as a ligature, it was prepared by simply soaking it in carbolic oil (1 in 5) for a couple of months, but it was found to soften and absorb too soon, and this and the length of time required for its preparation led to the introduction of the chromicised gut. Catgut may also be prepared by soaking in corrosive sublimate (1 in 100), or by exposure to a dry heat of 284° F. for a few hours.

It is a well-recognised fact, however, that, either from some imperfection or carelessness in its preparation, the catgut sold by instrument makers and others is not always aseptic, and indeed catgut which has been kept in watery or oily solutions of carbolic acid for many months has been still proved to contain micro-organisms, so that some surgeons have ceased to use it as a form of ligature, especially as they possess in silk a material which can be rendered absolutely aseptic and is therefore more certainly reliable. The advantage claimed for catgut is that it is more readily absorbed. Silk is only absorbed very slowly, but, as we shall see, the silk ligature very soon becomes surrounded by inflammatory products, which become organised and encyst it, and therefore even if remaining longer in the tissues it is quite innocuous. When a vessel has been tied with a catgut ligature and the wound remains aseptic, the ligature becomes surrounded by granulation tissue, the cells of which gradually invade and destroy it, and it completely disappears. If, however, the wound becomes septic, the ligature decomposes and softens rapidly, and thus it may leave the vessel unprotected before repair has sufficiently advanced to permanently seal it.

The old-fashioned **silk** ligature, when rendered perfectly aseptic, is the best and most reliable ligature that can be used. It is strong, inelastic, pliable, the knot is firm and not likely to slip, and when aseptic it fulfils all the requirements of a good ligature, except perhaps that it is very slowly absorbed, or, it may be, is not absorbed at all; but if this is the case, it soon becomes encapsuled and remains harmlessly among the tissues. Silk is an animal substance, which from its mode of preparation for commercial purposes is less likely to be infective, when it falls into the hands of the surgeon, than catgut. It can be rendered perfectly aseptic by prolonged boiling and immersion in a 1 in 20 solution of carbolic acid, in which it should be kept until required for use. When applied to a vessel in an aseptic wound, it becomes encapsuled and remains inert in the tissues for a considerable time without undergoing any change. It has been found in wounds at the end of six or seven weeks absolutely unaltered, but it is eventually slowly absorbed. The round cells penetrate between the fibres of the silk and slowly destroy and replace them.

Tendons, principally the tendons of the tail of the kangaroo, form an excellent ligature. They are strong and not so readily absorbed as catgut. The main objection to their use is that the knot is apt to slip unless tied very tightly. They are prepared by drying the tendons after they have been removed from the animal, and then soaking them in carbolic acid solution (1 in 20) for at least two days before they are used.

Ox-aorta ligature is obtained by removing the outer coat of the aorta of the ox, and then cutting the middle coat spirally into cords or bands of any required thickness. These cords are then suspended by one end, with a weight attached to the other, and allowed to dry. Before use they are soaked for some hours in strong carbolic acid solution, so as to render them aseptic. In Barwell's hands, who was the first to advocate their use, they have proved thoroughly reliable: they are strong and supple, and easily though not too rapidly absorbed.

With regard to the other forms of ligature, little need be said, as they are very seldom used. The metallic ligature is not absorbable, and though it becomes encapsuled, it often causes pain by irritating neighbouring nerves. Silkworm gut is not pliable, and it is difficult to tie in a knot that will not slip. Peritoneum cut in long strips has been recommended as a ligature, but has not been largely used. It behaves very much as catgut ligature, and is easily absorbed.

In applying a ligature to a cut artery, the vessel is to be seized with a pair of artery forceps, care being taken not to seize any of the surrounding tissues; it is then gently drawn out from its sheath for a short distance, and a ligature placed around it just beyond the point where it has been taken hold of by the forceps, and tied with a reef knot (fig. 83). Care must be taken not to tie what is popularly called a 'granny' knot, as it is apt to slip. The knot should be tied tightly, sufficiently so to rupture the internal and middle coats, though, as we shall point out presently, this is not necessary for the permanent occlusion of the vessel, but it is necessary for the firm holding of the ligature. If this is tied only sufficiently tightly to close the vessel, and prevent the passage of blood through its cut end, it will be likely to become displaced by the impact of the blood against it, and intermediate hæmorrhage will take place. When the extremity of a wounded artery is tied sufficiently tightly to prevent it slipping, the internal and middle coats are ruptured at the point where the ligature encircles the vessel by the force which is applied to tighten the ligature, and the divided coats are separated to a slight extent from the external one, and curl up into the lumen of the tube (fig. 84, A). An internal clot now gradually forms in the vessel, and in two or three days extends as high as the first collateral branch. The clot is conical in shape, its base soon becomes decolourised by the infiltration of leucocytes, and adherent to the upturned middle and internal coats; its apex is still dark coloured and floating in the vessel (fig. 84, B). The changes already described under the heading of Permanent Arrest of Hæmorrhage now take place; the cells of the endothelial lining of the vessel proliferate and invade the clot, which they gradually destroy and replace, becoming developed into a fibrous connective tissue, which becomes vascularised in the manner above described, and the vessel permanently sealed. The small portion of the vessel below the ligature becomes buried in the exudation which forms outside the vessel, and is readily taken up and absorbed by the cells of the granulation tissue.

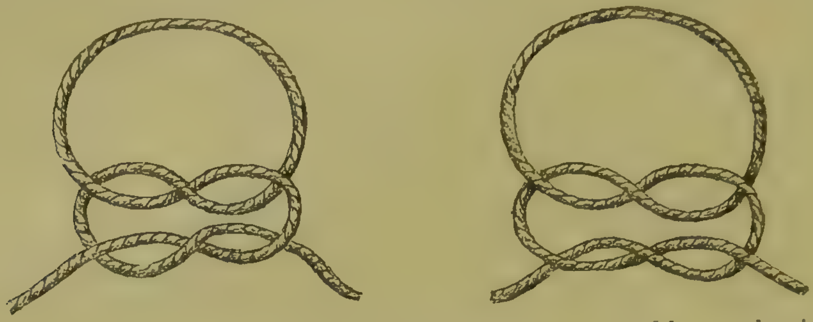

FIG. 83.—A reef knot. The left-hand figure represents the reef knot: the right-hand figure is a 'granny knot,' and has been introduced to afford a comparison between the two.

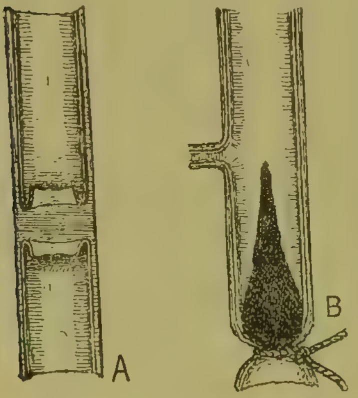

FIG. 84.—Ligature of an artery. A represents an artery to which a ligature has been applied tightly; then removed and the artery laid open. The internal and middle coats will be seen to have been ruptured, and to have become separated and curled up in the lumen of the tube. B shows the internal clot reaching to the first collateral branch.

Treatment of wounded arteries.—The rule which should guide the surgeon in the treatment of primary arterial hæmorrhage is that he should cut down and secure the injured vessel. If the vessel has been completely divided, he should ligature or apply torsion to both the distal and proximal ends: if it has been punctured or only partially divided, he should secure it both above and below the injury, and divide it between. This fundamental rule of surgery, that a wounded artery, if it is bleeding, should be secured at the place where it is wounded, is based on several considerations. 1. Unless the artery is exposed at the point where it is wounded, it is impossible always to determine what vessel is bleeding; and if the plan were adopted of ligaturing the artery higher up in its course, the wrong vessel might be tied. Take, for instance, a case of a stab in the front of the thigh, with sharp arterial hæmorrhage. It might be assumed that the superficial femoral was injured, and this vessel might be secured, while the bleeding all the time came from the profunda. Or in a punctured wound of the axilla, the axillary artery might be supposed to be injured, when the bleeding came from a wound of the long thoracic, subscapular, or other branch. 2. If a large artery is wounded, and is tied some distance above the wound, blood may find its way by the collateral circulation into the artery again, either above or below the wounded spot, and bleeding recur either from the proximal or distal end. 3. If ligature some distance above the injured spot fails to arrest the hæmorrhage, recourse will then have to be had to ligature of the bleeding artery in the wound, and thus the vessel is obliterated at two points, the establishment of collateral circulation is interfered with, and the risks of gangrene are greatly increased.

Ligature of an artery in its continuity.—The artery having been exposed in the manner which will be described in the sequel, the sheath is picked up with a pair of fine forceps, and the small portion seized is cut off by a horizontal sweep of the scalpel (fig. 85). This leaves a small circular hole in the sheath, through which the white coat of the artery can be recognised. The surgeon now takes hold of the margin of the opening with his forceps, and putting it on the stretch, proceeds to separate the sheath from the wall of the vessel in a circular manner as far as he can reach with a director (fig. 86). In doing this great care must be exercised

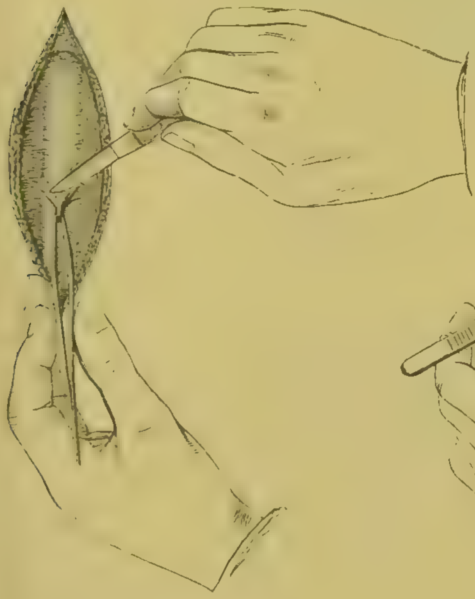

FIG. 85.—Opening the sheath. (From Erichsen's 'Surgery.')

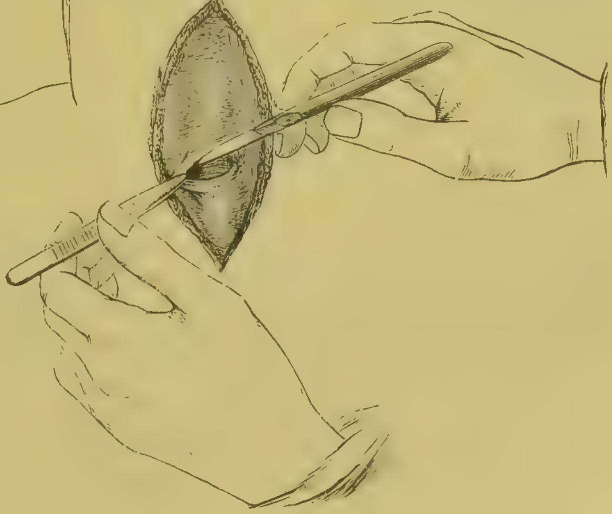

FIG. 86.—Cleaning the artery. (From Erichsen's 'Surgery.')

not to separate the sheath from the artery to a greater extent than is absolutely necessary to pass the aneurism needle, for the vasa vasorum which supply the coats of the vessel are derived from the vessels of the sheath, and if these are torn through to any great extent, the supply of blood to the vessel may be interfered with, and the isolated part slough. At the same time the small circle which has to be separated must be done so thoroughly as not to include any portion of the sheath in the ligature. Having completed this stage of the operation, the ligature has to be passed. This is done by means of an aneurism needle ;—a curved needle on a handle with a blunt extremity. This needle is insinuated round the artery, between it and the sheath, by an undulatory movement, the edge of the opening in the sheath being held on the stretch with forceps (figs. 87 and 88). The needle should always be passed *from* the most important structure which lies near it, and this is usually the vein. The rule is to pass the needle first between the artery and vein, and then around the vessel away from the vein. To this rule, as we shall see hereafter, there is an exception in ligature of the third portion of the subclavian artery. Having passed the needle, it is to be threaded and withdrawn : the ligature now encircles the vessel. There are two cautions to be observed in the performance of the operation : one is, that the coats of the vessel are never to be seized with the forceps in passing the ligature for fear of bruising them ; and the second is, to avoid injuring any small branch coming off from the artery, and if this is accidentally done, to tie it at once, otherwise oozing of blood may take place into the sheath, which may become widely separated from the vessel and gangrene of it may ensue. When the ligature has been passed, the cord should be tensed, and the vessel compressed between it and the finger of the operator, in order to ascertain that the circulation is arrested in the vessels beyond. This having been proved to be the case, and the surgeon being satisfied that he has included nothing but the artery in his ligature, it is to be tied by a reef knot, and the ends cut off, and the external wound sutured.

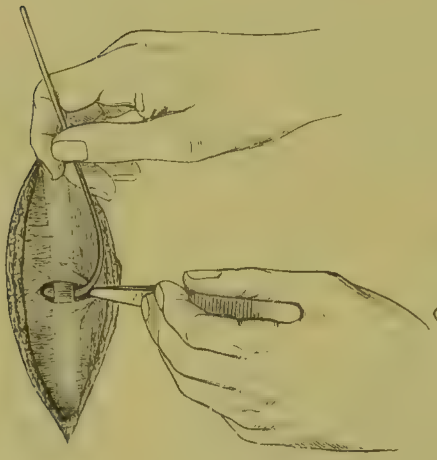

FIG. 87.—Passing the needle : First stage. (From Erichsen's 'Surgery.')

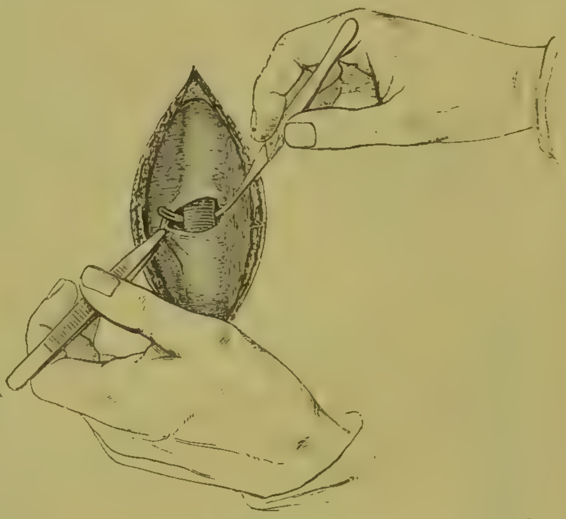

FIG. 88.—Passing the needle : Second stage. (From Erichsen's 'Surgery.')

The effects produced by the ligature of an artery in its continuity depend upon the amount of tightness with which the ligature is applied.

When the ligature is tied tightly the internal and middle coats are cleanly divided (fig. 84, A), separated to a slight extent from the external coat, and curled upwards and downwards in the lumen of the tube. An internal clot then forms both above and below the ligature, and the same changes occur as have already been described as taking place in ligature of the cut end of an artery, and the part of the vessel filled by the clot is converted into a fibro-cellular cord. The internal clot formed below the ligature is seldom so abundant or large as that formed above it. In addition to these changes which take place in the inner coats of the artery and in the interior of the vessels, changes are to be noted in the outer coat. Sometimes, if the ligature is applied very tightly, the external coat may be partially or completely divided, but at all events it is bruised and strangled, and the strangled zone is absorbed, so that the artery is eventually completely divided at the point of ligature, whether this latter is absorbed, encysted, or thrown off. If the divided ends are not perfectly sealed, this division of the vessel may prove to be a source of danger from secondary hæmorrhage, and there has been a growing feeling in the minds of surgeons of late years that it is safer to apply a ligature in such a way that there shall be no injury done to the coats of the artery; that is to say, that in tying the ligature the noose should only be drawn sufficiently tight to arrest the flow of blood through the tube, and not so tight as to rupture the internal and middle coat or strangulate the external. Experience has shown that where this is done it is quite sufficient to cause permanent occlusion of the vessel, for an internal clot forms, proliferation of the cells of the intima takes place as a result of the compression of the ligature, and a connective tissue cicatrix is formed in the artery on each side of the ligature.

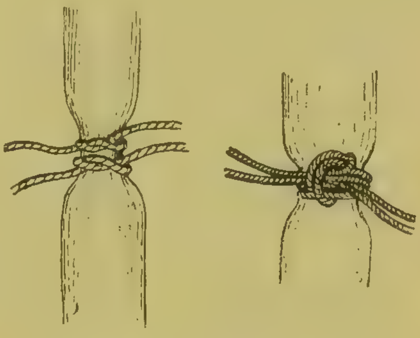
FIG. 89.—The stay knot of Ballance and Edmunds.

There are two objections which may be urged against this mode of applying a ligature. The one is, that it is extremely difficult to estimate how much force should be employed to completely arrest the flow of blood through the vessel, and still not to tear or lacerate its walls; for if insufficient force is applied the vessel will soon become pervious again, and the object for which the ligature was applied, frustrated. But with care this can be overcome. After the ligature has been made to encircle the vessel and the knot formed, the two ends should be very gently and gradually tightened until all pulsation has ceased in the vessels below, and then no further force should be applied. The other objection is, that after this has been done and the first knot tied, the force of the current of blood against the ligature is apt to make it slip before the second knot has been tied. To obviate this, Ballance and Edmunds have recommended that a double ligature should be passed. The ligature on the cardiac side is then tied in a single knot, which is held taut and acts as a 'stay,' while the other one is also tied in a single knot: the two ends on the one side are then tied to the two ends of the other to form the second knot (fig. 89). In operating in this way only the least absorbable ligatures should be used, such as silk or tendon, for if too rapid absorption of the ligature takes place the vessel will become pervious again.

A word or two must be said upon what will happen if a septic ligature is used. In these cases suppurative inflammation is set up in the neighbourhood of the ligature, ulceration of the external coat of the artery takes place, and the ligature comes away, after the artery has been completely divided. By the time that this has taken place, the formation of the internal clot and the permanent cicatrix is so far advanced that as a rule no hæmorrhage takes place. Should, however, premature separation of the ligature occur, or should the septic process extend to the coats of the vessel and they become softened and give way, then hæmorrhage will result. This will be alluded to again in considering the subject of secondary hæmorrhage. The average time for the separation of the ligature is about a week to ten days, but will depend to a great extent on the size of the vessel; in an artery the size of the subclavian or external iliac, separation may not occur till the sixteenth or eighteenth day.

Before finally leaving the subject of ligature of the arteries in their continuity, it is necessary to allude to an old-fashioned plan, which has lately been revived, of ligaturing the artery in two places and dividing the vessel between the two ligatures. The object of this is said to be to give more perfect rest to the injured vessel. An artery is always in a condition of tension, or more or less upon the stretch; and if the artery is tied in two places, and divided between, the longitudinal strain is removed. The proceeding involves considerably more interference with the artery; and except in those cases where too much of the sheath has been unavoidably separated from the artery, the better plan would appear to be to resort to the single ligature, and endeavour by attention to position to relax the vessel and keep it at rest after it has been ligatured.

When an artery is ligatured in its continuity all pulsation disappears in the vessels below, and the parts supplied by it become cold, blanched, and numb. Shortly, however, the collateral circulation becomes established, and by means of the numerous anastomoses which are normally present in the body, blood is carried to the parts below the ligature, the pulseless vessels begin to beat again, the part becomes warmer, and the pallor disappears. If from any cause the collateral circulation is not established, the parts supplied by the ligatured vessel die.

Failure in the process of arresting hæmorrhage.—Failure in the process of arresting hæmorrhages may give rise to Reactionary Hæmorrhage, Secondary Hæmorrhage, or Gangrene.

Reactionary or **intermediate hæmorrhage** is the bleeding which occurs during the first twenty-four hours after the receipt of an injury or the performance of an operation. During and immediately after an operation a patient is suffering from shock, his heart beats feebly, and the blood is propelled with little force through the vessels; moreover, the wound is exposed to the air, and this causes the vessels to contract, and therefore no bleeding takes place from vessels of even a considerable size; they escape the notice of the surgeon, and the patient is sent back to bed with them unsecured. As soon, however, as he begins to rally and becomes warmer, the contracted vessels dilate, the heart beats more forcibly, and the temporary clots which have formed in these unsecured vessels are expelled, and hæmorrhage takes place. The bleeding under these circumstances is never very severe, as it is only the smaller vessels which bleed. Intermediate hæmorrhage may also occur from the ligature giving way; this may arise from its not having been tied tightly enough to rupture the two internal coats, so that it is pushed off the end of the vessel by the repeated impact of blood against it, or it may be caused by the knot giving way from having been tied as a granny knot, or from the ends having been cut off too closely, or from the surgeon having used too rigid a material for his ligature, as badly prepared catgut or silkworm gut. If reactionary hæmorrhage occurs the blood distends the wound, causes great pain to the patient, and after a time soaks through the dressing and appears externally. The treatment consists in opening up the wound, turning out the clots, and securing the bleeding vessels. No doubt in many cases of reactionary hæmorrhage the bleeding may be arrested by raising the part and applying pressure, and this plan may be adopted if the wound is not distended with clot; but if the wound is distended with blood, it is a better plan to open it up and get rid of the clots, as they are a source of pain to the patient, and form an obstacle to the rapid union of the wound. The surgeon should always bear in mind the possibility of reactionary hæmorrhage occurring, and should not therefore be in too great a hurry to rally his patient from his faintness after an operation by the administration of stimulants, &c.

Secondary hæmorrhage is usually defined as bleeding which comes on at a later period than twenty-four hours after a wound has been inflicted until it is completely healed. It is, in fact, hæmorrhage which occurs in consequence of the failure of the process of repair of the wounded vessel. In a large proportion of cases secondary hæmorrhage occurs as the result of septic arteritis, going on to ulceration, and therefore it is of very infrequent occurrence at the present day; it may, however, also occur from the newly formed cicatrix giving way from the pressure of the blood behind it. Septic arteritis may be caused by the use of a septic ligature, or by the presence of an infective material in the wound. As a result of this, the coats of the vessel become infiltrated with micro-organisms, they undergo a progressive molecular disintegration, become softened and eventually give way, generally at one minute spot in the first instance, from which the progressive disintegration gradually increases. When an artery is tied in its continuity, the hæmorrhage most frequently occurs from the part of the artery which is distal to the ligature. The cause of this may be that the circulation in the vasa vasorum supplying this part of the vessel must necessarily be interfered with by the ligature, while it does not affect those vessels supplying the artery above the ligature.

Secondary hæmorrhage may occur from the giving way of the newly formed cicatricial tissue from the pressure of blood, before it has acquired sufficient resisting power to withstand the onward pressure. This giving way of the cicatrix may arise either from the increase of pressure from some constitutional causes, as cardiac hypertrophy or chronic Bright's disease, or from failure in the formation of the cicatricial tissue, from general causes such as septicæmia or pyæmia, hæmophilia, or cachexia, or from local causes, as the proximity of a large branch coming off from the artery close to the point of ligature, through which the blood continues to flow.

In the old days when ligatures had to separate by a process of ulceration of the outer coat of the vessel, secondary hæmorrhage most frequently occurred at the time of the separation of the ligature; namely, about the tenth day. In consequence of the septic changes going on in the wound, the proper development of granulation tissue and formation of a plug in the vessel was interfered with, and when the process of ulceration had perforated the external coat, hæmorrhage occurred. The way in which secondary hæmorrhage takes place is very characteristic. As a rule the opening in the wall of the vessel from which the blood issues is at first exceedingly minute, and only a few drops escape; then the hole becomes plugged with a clot, and no more bleeding occurs for some hours. As, however, the molecular disintegration of the coats of the artery proceeds, the clot becomes separated, and a fresh and rather more copious bleeding occurs, and may again be arrested by the formation of another clot, and so this recurring hæmorrhage goes on until the hole in the vessel has acquired a considerable size, and then a copious, and it may be fatal, hæmorrhage takes place.

Treatment.—When secondary hæmorrhage occurs after ligature of an artery, whether it is the end of a divided vessel in a wound or the artery has been ligatured in its continuity, the recognised rule in surgery is to take measures to secure the vessel, because it is certain that if secondary hæmorrhage has once occurred it will recur at no very distant period.

It will be convenient to consider the plan of treatment under two heads: (1) when the bleeding comes from the end of a divided artery, as in a stump; and (2) when it comes from an artery which has been ligatured in its continuity.

1. **Secondary hæmorrhage from a divided artery in a stump.**—If the bleeding has been slight, and the flaps are not distended with blood, it is justifiable to raise the stump, apply an artery compressor to the vessel above in order to diminish the blood pressure, and an elastic dressing and bandage to the stump itself. This *may* succeed, but if the bleeding recurs, or if the bleeding has been in the first instance considerable, the recognised rule in surgery is at once to open up the stump and attack the bleeding point. This is preferable to the alternative plan of ligaturing the main artery in a higher part of its course, for until the stump is opened up it cannot be ascertained from what vessel the hæmorrhage is coming, and the main artery may be ligatured unnecessarily and without doing any good in arresting the hæmorrhage. A tourniquet is first to be applied if this is possible, or bleeding controlled by digital compression on the artery above, and the stump freely opened up and the bleeding spot sought for. When this has been done, in some cases no hæmorrhage may occur; the surface of the wound should then be sponged over with a certain amount of force, so as to dislodge any clot which may have formed in the opening in the vessel. When the bleeding point is found, the vessel from which it comes must be carefully isolated from surrounding tissues and exposed until a part is reached which will bear a ligature, and there it must be tied. In doing this great gentleness must be used, and the ligature must not be tied sufficiently tightly to rupture the internal and middle coats. This proceeding is often a matter of considerable difficulty; the artery is embedded in a mass of inflammatory exudation, and its coats softened by the septic arteritis that has been going on, so that it is better to try and separate it by teasing it out with a director rather than by dissecting it out with a scalpel. In some instances it may be found to be impossible to isolate the vessel, or, if isolated, it may be found to be impossible to get a ligature to hold. Under these circumstances recourse may be had to the actual cautery, which must be applied at a dull red heat and held in contact with the bleeding point for some time till a deep eschar is formed. After the ligature has been applied and all bleeding arrested, the surgeon must endeavour to render the part aseptic by the free application of some antiseptic, such as chloride of zinc (gr. xl to ℥i),

otherwise a continuation of the process will lead to a recurrence of the hæmorrhage.

2. **Secondary hæmorrhage from an artery tied in its continuity.**—When secondary hæmorrhage occurs, at the point of ligature, from an artery tied in its continuity, and it is only slight in amount, an attempt should be first made by a graduated compress and bandage to arrest the bleeding; but if the hæmorrhage is at all severe, or if the compress and bandage fail to arrest it, the wound must be opened up and a ligature placed upon the vessel above and below the bleeding point. Should this not be practicable, or should it fail and the bleeding recur, the plan of treatment must differ as to whether the bleeding artery is in the upper or lower extremity. If it is in the upper extremity the right course to pursue is to cut down upon and ligature the vessel higher up, for here there is a fair chance of no gangrene occurring after the double ligature. In the lower extremity gangrene is almost certain to follow the ligature of the femoral artery in two places, and therefore it is advisable to at once proceed to amputation of the limb immediately above the spot where the artery was ligatured in the first instance.

Gangrene after ligature of an artery in its continuity.—Almost always after ligature of an artery the collateral circulation is sufficient to maintain the vitality of the parts supplied by the vessel which has been tied, so that when gangrene occurs after this operation it is generally due to some obstruction to the venous circulation, and is therefore of the moist kind. In every case after ligature of an artery the venous circulation is carried on with difficulty, because the vis a tergo, the principal cause of the flow of blood through the veins, is lost, and any slight cause may produce a thrombus in the veins, and a complete stagnation of the venous flow, and gangrene will be the result. Thus the coats of the vein may be bruised in passing the aneurism needle, and this may lead to thrombosis. Where the vein is accidentally included in the ligature, or where it is transfixed by the aneurism needle, an accident which has been known to occur, it becomes blocked and gangrene is the result. This form of gangrene generally occurs about the third day after the ligature. It may or may not extend up to the level of the seat of ligature, and is attended with some constitutional symptoms from the absorption of toxic products from the bacteria of decomposition. It is much more common in the lower extremity than in the upper.

Treatment.—Much may be done to arrest this form of gangrene when it is impending by (1) raising the limb slightly so as to facilitate venous return. If it is in the lower extremity care must be taken not to raise the limb too much, otherwise a bend or kink will be produced in the common femoral opposite the hip joint, which will interfere with the current of blood through the vessel. (2) By maintaining the natural warmth of the part by swathing it in medicated wool and a flannel bandage, and placing hot-water bottles in the bed, but not in contact with the limb. If placed in actual contact with the part they may over stimulate the circulation, and cause sloughing. (3) By employing methodical and continuous friction in the course of the venous circulation. If moist gangrene actually supervenes, amputation should be performed at once at the level of the point of ligature.

In some rare instances, dry gangrene may follow ligature of an artery. This, however, only occurs when there is some other antecedent cause which interferes with the supply of blood to the part, as disease of the coats of the collateral vessels, preventing them from conveying the increased quantity of blood required; or disease of the heart, enfeebling the force of the circulation; or a great loss of blood, diminishing the blood pressure. In these cases the gangrene may be limited—confined, it may be, to a single toe or the point of the heel after ligature of the femoral. It may be much longer in making its appearance, being sometimes delayed as long as three weeks from the time of the operation, and it is unattended by any constitutional disturbance. Here immediate amputation is not called for. The surgeon should wait for a line of demarcation to form, and indeed in most cases it is advisable to allow the dead parts, if the gangrene is limited, to separate of themselves, hastening matters by dividing any bones or tendons which take a long time to separate. The parts should be kept aseptic—perhaps wrapping the part in a muslin bag loosely filled with animal charcoal is as good an application as any. It is better than iodoform, which is apt to interfere with the patient's digestive functions and destroy his appetite. Small doses of opium should be given to allay nervous irritability, and the patient's strength supported by careful dieting, nutritious and easily digested food being given, with stimulants if required.

TRAUMATIC ANEURISMS

An aneurism may form as the result of an injury to an artery. It is then called a **traumatic aneurism.** An aneurism may be defined as a sac containing blood and communicating with the interior of an artery. In a spontaneous or idiopathic aneurism the wall of the sac is formed for the most part by one or more of the coats of the vessel, but in a traumatic aneurism this is not so, the arterial wall not taking any part in the formation of the sac. The condition is produced by an injury which divides all the coats of the artery, and allows the blood to escape into the surrounding tissues.

Causes.—The injury to the artery may be produced in several different ways. It may be (1) a subcutaneous laceration of the coats of the vessel from a strain, as in reducing an old dislocation of the shoulder joint or from hyper-extension of the knee; or the artery may be subcutaneously lacerated by a sharp end of a fractured bone. (2) An artery may be divided by a wound from without, and owing to some cause the blood cannot escape externally, but collects in the tissues around the vessel. The impediment to the escape of blood may be that the wound is very oblique, so that the blood can find no ready exit; or it may be that the external wound may be closed by artificial pressure, so that the fluid cannot escape externally, while at the same time the opening in the vessel is not closed, so that the blood which is poured out from it collects in the tissues around. (3) The artery may be punctured without being divided completely across. It cannot then contract and retract: its lumen is not obliterated by an internal clot, and therefore no perfect healing of the wound in the vessel takes place. A clot may form which arrests hæmorrhage for a time, and the external wound may heal. Then the clot becomes displaced, and renewed bleeding into the tissues occurs. Or, in other cases, the wound in the artery may become closed by a cicatrix, but the scar is weak and yielding and the pressure of the blood in the vessel causes it to yield and an aneurismal sac is formed, the wall of which consists of the dilated cicatrix.

Varieties of traumatic aneurism.—Traumatic aneurisms may be divided into two classes: (1) those where the artery alone is involved in the injury: and

(2) those in which the accompanying vein is also injured—these latter are termed *arterio-venous aneurisms.* The **true traumatic aneurism,** where the artery alone is involved, shows itself in two or three different forms according to the amount of blood which is effused. In some cases, where the artery injured is of large size, and where an immense quantity of blood is effused very rapidly, the term aneurism is inapplicable, though it is sometimes applied. It is more appropriate, however, to classify these cases as subcutaneous arterial hæmorrhages. They have already been alluded to under the head of Ruptured Arteries (see page 280). But there are other cases, where, on account of a smaller vessel being ruptured, or from a small opening being made in the torn vessel, or on account of the resistance of the tissues to the infiltration of blood, the amount extravasated is not so great, and it becomes imperfectly limited in a cavity around the injured vessel, the walls of which are formed of clotted blood, which becomes firm and resistant from the pressure to which it is subjected. This is termed a *diffuse traumatic aneurism.* Again, there are other cases where the extravasation of blood is still smaller and takes place more slowly, and under these circumstances a distinct sac wall is formed around the extravasated blood by condensation of the surrounding tissues by inflammatory exudation. This is known as a form of *circumscribed traumatic aneurism.* And in addition to this there is another form of circumscribed traumatic aneurism, where, as mentioned above, the cicatrix of a punctured artery yields, and the wall of the aneurism is formed by the scar tissue.

Diffuse traumatic aneurism.—A diffuse traumatic aneurism is characterised by the formation of a rapidly growing swelling in the course of an artery, following an injury. The swelling is ill defined, usually tense and firm, but varying somewhat in consistence according to the amount of coagulation which has taken place. The skin over it is tense, and though natural in colour at first, soon becomes discoloured from some of the extravasated blood finding its way to the surface. In many cases an indistinct pulsation, accompanied by a distinct bruit, and sometimes a thrill, may be noticed in the earlier stages, but these soon disappear as the extravasated blood coagulates. There is coldness and lividity of the limb below the injury, with œdema, and the pulse is lost or weaker than on the opposite side of the body. Intense pain is complained of, which may frequently be temporarily relieved by compressing the artery above. Owing to the absence of any true sac wall, a diffuse traumatic aneurism tends to increase at first rapidly and then more slowly. It ends in one of three ways: (1) It may reach the surface, and then burst and cause severe and even fatal hæmorrhage. (2) It may, on account of the tension, give rise to acute inflammation in the tissues around. The swelling becomes hot, the skin over it red, and the subcutaneous tissues œdematous, and throbbing pain is complained of. The temperature is raised. After a time the swelling points, like an abscess, bursts, and gives rise to a gush of broken-down blood clot, followed by profuse hæmorrhage, which may at once prove fatal. (3) A diffuse traumatic aneurism may be followed by moist gangrene in the parts below. The **treatment** of diffuse traumatic aneurism is the same as that of a ruptured artery—the vessel must be tied above and below the injured spot. If the aneurism is in one of the extremities, so that a tourniquet can be applied and the circulation through the part entirely controlled, the operation is one of no great danger, but of considerable difficulty; but if the aneurism is in such a situation that the vessel above cannot be compressed, the operation is not only one of great difficulty, but also of danger from hæmorrhage. In the former case, a tourniquet should be applied, the swelling freely incised, the whole of the coagula carefully sponged away, and the two ends of the artery sought for, and when found ligatured. This must be done with the strictest antiseptic precautions, otherwise the extravasated blood, which still infiltrates the surrounding tissues, will undergo decomposition and give rise to acute septicæmia.

When the main artery cannot be controlled, freely incising the swelling in the manner described above would probably cause fatal hæmorrhage. A small incision is therefore to be made in the sac sufficiently large to admit of the introduction of the index finger, and this is to be immediately inserted as soon as the opening is made, in order to plug it. Search is now to be made with the finger in the interior of the sac for the opening in the vessel. This can generally be felt by the surgeon as a constricted ring in the position in which the artery is known to be, or he may recognise the stream of warm blood issuing from it. When the opening is found, he makes firm pressure in this situation, against a bone, if there is one in the neighbourhood, and introducing a blunt bistoury along the finger, slits up the sac and rapidly turns out the clots. With the forefinger still making pressure on the opening in the artery, he exposes the vessel and encircles it with a ligature, which he ties. There is often considerable difficulty in doing this, and in most cases it is better to entrust the ligaturing of the vessel to a competent assistant while the surgeon restrains the hæmorrhage, or the surgeon may replace his finger which controls the vessel by that of an assistant, so as to have both hands free for the subsequent steps of the operation. After the proximal end of the artery has been secured, search must be made for the distal end if the vessel has been completely divided, or for the artery below the wound if only partial division has taken place, and a ligature must be placed around it and tied.

Circumscribed traumatic aneurism.—A circumscribed traumatic aneurism is where the amount of blood effused is small, and where it becomes surrounded by a distinct sac wall. The reasons why the extravasation of blood is small in amount may be : (1) because the flow is restrained by a pad and bandage placed over the wound by the surgeon to restrain the hæmorrhage ; or (2) because the blood is prevented from escaping in large quantities by some dense fascia or resisting structure, as the palmar fascia in wounds of the palmar arch, or the aponeurosis covering Hunter's canal in punctures of the femoral artery in the middle of the thigh ; or (3) when, on account of the patient becoming faint, a clot forms in the opening in the vessel and stops the bleeding. After the aneurism has formed, the symptoms are those of an ordinary idiopathic aneurism, which will be described in the sequel, but it can always be diagnosed from this form of aneurism by the history of a wound, followed by severe hæmorrhage, and by the presence of a scar over the summit of the swelling, unless the aneurism was the result of a subcutaneous lesion of the vessel, when there will be nothing but the history of the accident to guide one in the diagnosis. Circumscribed traumatic aneurisms arising in this way are, however, very rare.

This form of aneurism may undergo spontaneous cure in the same way as an idiopathic aneurism, but in the major number of cases it increases slowly but surely, and eventually ruptures.

Treatment.—In some cases, if the sac is very clearly defined and circumscribed, it may be possible to cure an aneurism of this kind by well-directed pressure, but in most cases operative interference is necessary. The mode of operation which holds out the greatest prospect of cure is, after commanding the circulation in the artery above, to lay open the sac, turn out its contents, and tie the artery above and below the aneurism. This should be done with all antiseptic precautions, and the wound will probably heal by first intention. In some few cases, where the sac is deeply placed or difficult to get at, it may be advisable to tie the vessel on the cardiac side of the sac.

Arterio-venous aneurisms.—An arterio-venous aneurism may be defined as an abnormal communication between an artery and a vein. The communication is almost always the result of injury, and in former days commonly occurred from the puncture of the brachial artery through the median basilic vein in the operation of venesection, the superficial wound in the vein healing, but the deeper wound in this vessel and the wound in the artery remaining patent and communicating with each other. Arterio-venous aneurism was also caused in former days from gunshot wounds, in which the old leaden bullet passed between an artery and vein, bruising the coats of both, without dividing them; subsequent sloughing established a communication between the two vessels. Cases of arterio-venous aneurism have, however, been recorded which were not due to traumatism, but resulted from ulceration taking place between an artery and vein, where they were in contact, and thus forming a communication. And one case has been recorded where an arterio-venous aneurism was believed to be the result of a congenital communication between the common iliac artery and vein where they cross each other.

Arterio-venous aneurisms are of two kinds, which are quite distinct from each other, and differ in their symptoms, their progress, and their treatment. They are named aneurismal varix and varicose aneurism.

Aneurismal varix.—The aneurismal varix is the more common of the two conditions, and is a direct communication between an artery and a vein (fig. 90, A). The margins of the wound in the one vessel adhere to the margins of the wound in the other, so that the blood in the artery finds its way directly into the vein. The result of this is that there are two opposing currents in the vein, the one, the venous current, flowing towards the heart: and the other, the arterial current, which has passed through the artificial opening, and flows in the opposite direction. In consequence of

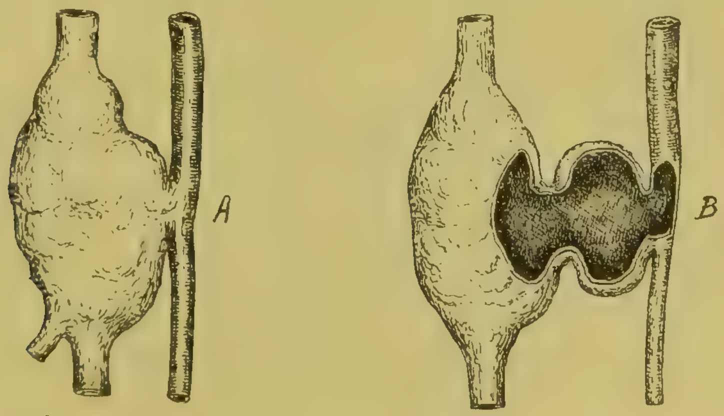

FIG. 90.—Arterio-venous aneurisms. A, Aneurismal varix; B, Varicose aneurism.

this the vein both above and below the point of communication becomes dilated into a fusiform pouch, and its coats thickened. The tributaries of the vein, owing to the retarded venous flow, become enlarged and varicose; a condition of passive congestion is set up, and œdema of the limb is the result. The artery above the opening becomes dilated and its walls thinned, while below it is generally slightly smaller than natural.

Symptoms.—A soft, compressible tumour is perceived over the situation of the wound, which, if the vein which has been injured is superficial, is of a bluish colour. The tumour is ill defined, and appears to shade off into several dilated veins which may be seen running into it. It varies in size, increasing if the limb is placed in a dependent position, and diminishing if the limb is raised; if the circulation in the artery is stopped above the swelling, it almost entirely disappears. The tumour pulsates with a tremulous motion, and there is a marked continuous vibratory thrill. On auscultation a loud, rasping bruit can be heard, and indeed is sometimes audible to those standing around the patient's bed. The patient usually complains of acute pain, especially when the limb is dependent, and the pain is often relieved by raising the limb. The parts below are cold and œdematous.

Treatment.—The swelling has a tendency, at all events in many cases, after attaining a certain size, to remain stationary, and this induced surgeons in former days to discountenance operation in these cases, and to recommend for the relief of their patient an elastic stocking or armlet, which, indeed, is all that is necessary to relieve the patient of his pain, and enable him to get about. In these days, however, when operative interference can be undertaken with a minimum amount of risk, it would appear to be better to cure the disease altogether by ligaturing the artery above and below its communication with the vein, rather than resort to these palliative measures. This proceeding is necessary in those cases where the swelling is steadily increasing.

Varicose aneurism.—The varicose aneurism is where there is an indirect communication between an artery and a vein, a sac, which communicates with both, being developed between them (fig. 90, B). The blood from the artery finds its way through the communication into the sac, and then passes from the sac into the vein through the other opening. This form of arterio-venous aneurism is generally traumatic, and results from blood being effused between the two vessels, which consolidates, and a sac wall forms around the extravasation, exactly as in an ordinary circumscribed traumatic aneurism, from which it only differs in the fact that it communicates with a vein as well as an artery. In rare cases varicose aneurisms may be formed in other ways; for instance, an aneurismal varix may become converted into a varicose aneurism, by the stretching of the cicatricial tissue which joins the openings in the two vessels in the former condition; or, again, an idiopathic aneurism may press upon and eventually open into a vein, and thus form a varicose aneurism.

Symptoms.—In a varicose aneurism there are two swellings which may be differentiated from each other: a soft compressible swelling superficially, which is the dilated vein; and beneath this a firmer, more solid swelling, which is the aneurismal sac between the artery and the vein. If the circulation through the part is arrested by compressing the artery above the swelling, the superficial tumour disappears, and we are then able to distinguish the outline of the more solid tumour underneath, which does not disappear. We have therefore in a varicose aneurism a combination of an ordinary traumatic aneurism and an aneurismal varix. The sounds heard in these tumours are two: in addition to the loud rasping bruit, similar to what is heard in an aneurismal varix, and which arises from the communication between the artery and vein, there is a soft blowing systolic murmur caused by the aneurism. In the aneurism itself there is a distensile pulsation synchronous with the pulse, while in the dilated vein over it there is the continuous thrill similar to that felt in an aneurismal varix.

Treatment.—As the aneurismal sac has a tendency to increase in size and eventually burst, operative interference is necessary. Some few cases have been recorded where a cure has been effected by digital compression applied at the same time to the artery above the tumour and to the opening of communication between the aneurismal sac and the vein, but the treatment is very uncertain, and has failed in very many instances; it seems better, therefore, to expose the aneurismal sac, lay it freely open, turn out the coagula, and tie the artery above and below the opening of communication. The operation is best performed by opening first of all the dilated vein, and tying it on either side; a director is then introduced through the opening between the aneurismal sac and the dilated vein, and the sac slit freely open, when the wound in the artery will be found after the clots have been removed, and a soft bougie introduced through this will form a guide to finding the artery.

DISEASES OF ARTERIES

Arteritis.—Inflammation of arteries may be divided for purposes of description into Acute and Chronic Arteritis.

Acute arteritis presents itself under two different forms: (1) plastic or aseptic, and (2) septic arteritis.

1. **Plastic** or **aseptic arteritis** is the result of traumatism and is strictly local. It can scarcely be regarded as a disease, since it is nature's process of repairing injury. It is strictly analogous to the process of healing of wounds in the soft parts by first intention, consisting in hyperæmia, effusion of inflammatory products and their organisation, which either occludes the end of a divided artery or scars a wound in a vessel which has been only partially divided. It has been described in the section on Arrest of Hæmorrhage (page 288).

2. **Septic arteritis.**—This is an acute inflammatory process, caused by the introduction of pyogenic micro-organisms. These organisms may either be introduced from without, from a septic ligature, or from extension of suppuration in the neighbouring tissues to the wall of the vessel; or from within, from an infective embolus which has been washed into the vessel from, for example, one of the aortic valves in a case of ulcerative endocarditis, and where the micro-organisms find their way from the plug into the wall of the vessel.

The disease is attended by all the phenomena of inflammation; the vasa vasorum become dilated, then stasis and emigration of the blood corpuscles take place, and the walls of the vessel become infiltrated with leucocytes. The coats of the vessel become softened and ulcerate. While this has been going on a clot forms in the interior of the vessel, and this clot often extends beyond the infected part. Were it not so, hæmorrhage would invariably take place when the walls of the artery became softened and broken down; but, as a matter of fact, that portion of the clot which extends beyond the infected area in the vessel occludes the lumen of the tube at this point, and the vessel becomes sealed by plastic arteritis, and thus no hæmorrhage occurs. But though this process frequently takes place in smaller vessels, it does not do so in the larger arteries to nearly the same extent when they are affected with septic arteritis, probably because the strength of the current interferes with coagulation; therefore the risk of hæmorrhage in these cases is much greater. In cases of septic arteritis from an infective embolism, the softening of the vessel may stop short of actual giving way, and then the softened coats of the vessel may bulge from the pressure of the blood above the clot, and thus an aneurism may be formed. It is probable that all cases of aneurism in young subjects are due to this cause.

Chronic arteritis.—Several forms of chronic arteritis have been described. The principal of these are: (1) atheroma, (2) syphilitic arteritis, (3) tuberculous arteritis, and (4) arteritis obliterans.

1. **Atheroma: chronic endarteritis: arteritis deformans.**—These terms are applied to an affection of the arteries which is of extremely common occurrence after a certain period of life. It consists of an inflammation commencing in the deeper layer of the intima, and is of great importance, and may in many ways, either directly or indirectly, lead to grave results.

The disease begins as small isolated streaks, which coalesce and form round or oval patches, slightly raised above the surface. They are firm in consistence, and are at first of a greyish, semi-transparent appearance, but soon become opaque, yellow, and softer.

The disease begins as a round-celled infiltration of the deeper layer of the intima. These round cells are derived from a proliferation of the ordinary connective tissue cells of the part. Conjoined with this there is an increase of the fibrous tissue, the laminæ of the coat becoming thickened by a fibrinous deposit. The cells are arranged for the most part parallel to the lamellæ. No vessels are to be found in this new tissue, which for some time remains covered by the endothelium and sub-endothelial layers of the intima. From want of nutrition the cells undergo fatty degeneration, which accounts for the change of colour to an opaque yellow which the patch speedily undergoes. One of two changes may now take place; the patch may undergo liquefaction, or it may calcify. When liquefaction takes place, the fatty degeneration is attended with softening, and the patch is converted into a cavity containing fluid, consisting of fat granules and oily material, with cholesterine. The cavity is still covered superficially by the endothelium and sub-endothelial layers of the intima. It is termed an *atheromatous abscess*. The thin covering of this cavity, after a time, gives way, and the contents are discharged into the blood stream; the solid particles, being non-infective, do no harm even though they may be arrested in the capillaries beyond. After the discharge of the contents of the 'abscess,' an excavated surface is left on the remains of the intima, which is termed an *atheromatous ulcer*.

When calcification occurs a deposit of fine granules of lime salts takes place in the atheromatous patch; these coalesce and form a plate, which at first is covered by the superficial layers of the intima; after a time, however, these layers are apt to give way, leaving the plate exposed in whole or in part; it then attracts the leucocytes, which adhere to it, disintegrate, and so cause coagulation and the formation of a thrombus; or portions of the plate may become detached, carried into the blood stream, and form an embolus in some distant vessel. This condition is known under the name of *laminar* calcification or *secondary* calcification, to distinguish it from the 'primary' calcification of the middle coat (fig. 91). After the formation of the atheromatous patch in the deeper layers of the intima, the other coats of the artery become involved. The middle coat becomes infiltrated with round cells, and the muscle cells become destroyed and replaced by cellular growth; the outer coat becomes much thickened by the formation of a compensatory fibroid material.

Causes.—Atheroma is a disease of advanced life, and is produced by long-continued mechanical strain. There is abundant evidence to prove that anything which increases the strain or pressure of the blood within the vessels tends to produce atheroma. Thus, it is more frequent in men than in women, and when it occurs in the latter sex it is found in those who have been engaged in laborious occupations. Again, the positions in which it is found in the arterial system are those where there is the greatest amount of strain. It is most common in the arch of the aorta, which has to bear the greatest strain at each contraction of the ventricles. It is also frequently met with at the points of bifurcation of the arteries, or around the orifices of lateral branches, or where an artery is curved or rides over a bone, situations in which necessarily the pressure or strain must be greater than elsewhere. Thirdly, certain constitutional conditions in which there is increased pressure in the vessels tend to produce atheroma. Thus in Bright's disease, in which obstruction to the flow of blood through the arterioles and capillaries is set up by the arterio-capillary fibrosis induced by the renal trouble, and consequently increased pressure behind in the larger vessels, atheroma is exceedingly common. Gout acts

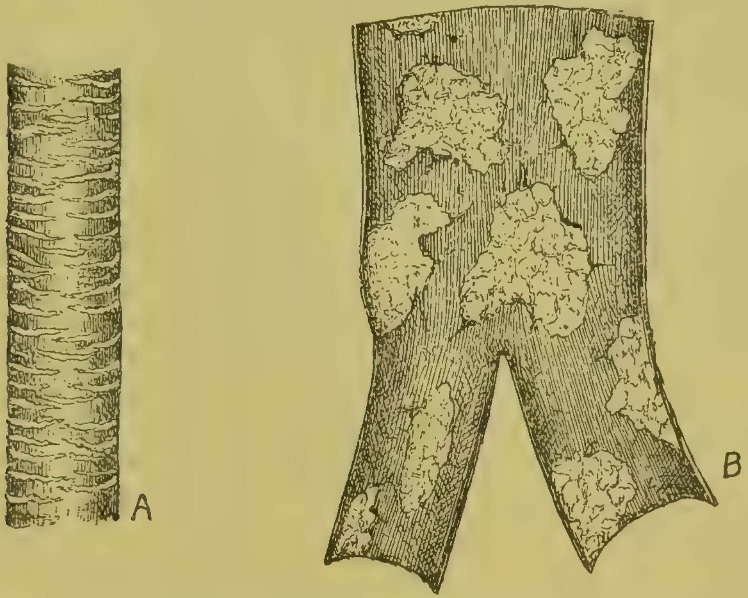

FIG. 91.—Calcification of arteries.
A, Primary or annular calcification; B, Secondary or laminar calcification.

in the same way by causing renal disease, and is a frequent cause of atheroma. Alcoholic excesses may cause atheroma, either from the cardiac excitement which it sets up or from producing disease of the kidney. Plethora also, by increasing the pressure of the blood within the vessels, is a cause of this disease.

In addition to mechanical strain as a cause of atheroma, syphilis has been credited with having some influence in the production of the disease, but this has been by no means proved. Nevertheless, syphilis may secondarily produce atheroma, for it undoubtedly induces a disease of the arterial system, principally affecting the smaller arteries, which narrows their lumen, and therefore, by producing mechanical strain in the larger vessels, may be a cause of the disease.

Signs.—When atheroma is well established it can be recognised in the superficial vessels, such as the temporal, by their elongation and tortuosity, and also by the 'locomotion,' as it is called, of the vessel; that is, a change in the position of the vessel with each contraction of the ventricles. The pulse is also less compressible than in the normal vessel. The circulation in the extremities is usually feeble, and their nutrition interfered with on account of the loss of elasticity induced in the vessels by the disease.

Effects.—The result of chronic endarteritis is to destroy the elasticity of the vessels, for it is the elastic coat which is principally involved. In consequence of this, when the vessels are expanded at each pulse wave they are unable to contract, and thus become permanently dilated. Atheroma is, therefore, the great cause of aneurism. Again, atheroma produces interference with the nutrition of the parts supplied by the diseased vessels; not only by destroying the elasticity of the vessel, but also by narrowing the orifices of lateral branches by the deposit of atheromatous material around them, and thus preventing the passage of the proper amount of blood to the part. A good illustration of this is afforded by the coronary arteries, the orifices of which are frequently narrowed by atheroma of the aorta, and as a result there is malnutrition of the muscular walls of the heart, and as a consequence fatty degeneration.

As we have already noted, atheroma, when it has proceeded to the calcareous stage, may also produce grave results, from the formation of a thrombus on the exposed calcareous plate, or from a portion of the plate becoming detached and entering the blood stream, and forming an embolus in some distant vessel. Finally, arteries which are the seat of chronic endarteritis are much more liable to give way and rupture from external violence than a healthy vessel, and the surgeon should always bear this in mind in applying force to some part of the body, as in reducing an old dislocation in an individual who presents evidence of this disease in his blood-vessels. Moreover, injuries to arteries which are the seat of atheroma are less rapidly and perfectly repaired than corresponding injuries in healthy vessels.

2. **Syphilitic arteritis.**—There is a form of arteritis principally affecting the smaller arteries, which appears to be due to the direct effect of the syphilitic poison, and in this presents a marked contrast to chronic endarteritis. It is said by Barlow to be especially common in individuals affected with the hereditary form of the disease. The condition principally affects the internal coat, and would appear to be of the nature of a gummatous infiltration. This coat becomes enormously thickened by becoming infiltrated with a material like granulation tissue. Cells appear beneath the endothelium; they multiply and enlarge until the internal coat

becomes so thick as to convert the lumen of the tube into a mere slit or even to occlude it altogether. Vessels are formed in this new material by the extension into it of buds from the vasa vasorum. The cells then show some tendency to develop into fibrous tissue, much in the same way as ordinary granulation tissue does. The middle coat of the artery is not usually implicated in the disease, but the external coat generally becomes thickened by the formation of new fibrous tissue in it. The disease is chronic in its nature, and very frequently attacks the vessels at the base of the brain. In consequence of the narrowing of the lumen of the vessel, there is malnutrition in the parts supplied by it, and this, when occurring in the brain, may lead to softening. In some cases thrombosis may take place in the narrowed vessels, and the circulation through them be completely arrested.

The arteries in a gummatous tumour undergo this same disease. A gumma in its earliest stage is abundantly vascular, but in spite of this it rapidly undergoes degenerative changes, and this is due to the fact, as pointed out by Greenfield, that the arteries of the gumma become affected with syphilitic arteritis, and the lumen of the tube being occluded by the thickening of the intima, malnutrition is induced and the consequent degeneration which is the constant fate of a gumma.

3. **Tuberculous arteritis.**—It has been pointed out by some that a very similar condition to syphilitic arteritis is found in the arteries of parts which are the seat of tuberculous lesions. It is supposed that the tubercle bacillus finds its way into the coats of the vessel, and then sets up changes which principally affect the intima, resulting in proliferation of its endothelium ; round cells are formed which infiltrate this coat of the vessel and cause it to become enormously thickened, so that it completely or almost completely obliterates the lumen of the tube.

4. **Obliterative arteritis** is a very rare form of disease, which consists, like the two varieties of disease of arteries we have just considered, in a proliferation of the endothelial cells of the intima, but arises quite independently of any syphilitic or tuberculous condition. Its cause is quite unknown. It occurs independently of any constitutional condition, and is not caused by injury of any kind. One of its great characteristics is its spreading nature ; beginning in the smaller arteries, it gradually extends along them until it reaches the larger vessels. It most frequently occurs in the extremities, both upper and lower. The disease begins as a proliferation of the endothelial and sub-endothelial cells of the intima, which goes on until there is complete obliteration of the lumen of the tube. In this proliferated tissue new vessels are developed by an extension of the vasa vasorum into it, and it becomes converted into fibrous tissue. The middle and external coats are also infiltrated with the same cells, but to a much less extent.

Symptoms.—The parts supplied by the vessel become pale, livid, and cold, and may run on to dry gangrene. Intense pain of a gnawing character is complained of. The diseased vessels can be felt as hard, enlarged cords, with very feeble pulsation.

Treatment.—The only thing that can be done is to treat the malnutrition on general surgical principles. The parts must be kept at rest, and protected from cold by being swathed in cotton wool. Opiates may be necessary to allay pain. If the parts become gangrenous amputation may be called for, and has been done in some cases with success.

Periarteritis.—Before leaving the subject of inflammation of arteries, it is necessary to allude to a rare disease, which has been named periarteritis. It is an inflammatory condition of the sheath and outer coats of arteries, and is attended by an accumulation of small round cells in the perivascular sheaths. It has been described by Charcot as of not uncommon occurrence in the arteries of the brain, and he believes that it is a common cause of apoplexy.

Primary degeneration of arteries.—The arteries are liable to undergo several different kinds of degeneration, of which calcareous, fatty, bony, and lardaceous degenerations are the principal.

Calcareous degeneration is the most important, and occurs as a primary change in the middle coat of the arteries, and must not be confounded with the secondary calcification of atheromatous patches, already spoken of. The disease is one of old age, and is due to senile changes; no other cause is known for it. It consists in a deposit of lime salts in the muscle cells of the middle coat, and as these cells are arranged circularly and transverse to the axis of the vessel, when they become calcified they present the appearance of calcified rings, and this is known as *annular* calcification, and is readily to be distinguished from the plate-like, laminar calcification of atheromatous tissue (fig. 91). In advanced stages of annular calcification, the rings coalesce together, and convert the artery into a rigid tube. This is known as *tubular* calcification. It occurs in the smaller arteries, in which the muscular coat is more largely developed, and in this presents a marked difference to atheroma, which, as we have seen, affects the larger vessels where the elastic coat is in excess. The condition can easily be recognised by the sensation which is conveyed to the finger upon feeling one of the superficial vessels, such as the radial at the wrist or the temporal; it may be not inaptly compared to a piece of whipcord—a hard, rigid cord, with a slight irregularity or roughness. There is a very feeble pulsation.

The circulation through a calcified artery is impeded, in the first instance, by the loss of the contractility and elasticity of the vessel, and, secondly, by the diminution of the calibre of the tube; the result of this is that the parts supplied are cold, become wasted, there is perverted sensation, sometimes 'pins and needles,' itching, or ill-defined pain, and frequently cramp of the muscles.

Thrombosis is sometimes the result of primary calcification. This is believed to be caused by detachment of the intima owing to malnutrition, because it is unable to obtain sufficient nutritive material from the vasa vasorum in the outer coat through the diseased middle coat. When it occurs, it leads to gangrene. Calcification, therefore, constitutes an important factor in the production of senile gangrene. It may also produce gangrene in another way. If any obstruction to the main vessel of a limb takes place, as from a ligature or embolus, if the arteries have undergone primary calcification, gangrene is very likely to follow, because the calcified vessels are unable to enlarge, and hence the collateral circulation cannot be established so as to maintain the nutrition of the limb. The change in the middle coat renders it very fragile, and it is apt to give way under the slightest violence; but, in spite of this, these vessels can in most instances be dealt with surgically when divided, either by tying or twisting, almost as safely as a healthy artery can, because the external coat is not involved in the disease and remains tough and strong. In some cases the vessel gives way upon any attempt being made to apply a ligature to it.

The other forms of degeneration of arteries are of little surgical importance. Primary **fatty** degeneration is a disease of the lining membrane, beginning in the sub-endothelial layer as yellowish patches, very slightly raised above the surface. They can be easily stripped off, producing a slight superficial erosion, but leaving the subjacent tissues natural. This is believed by some to be the starting point of dissecting aneurism. It occurs in young anæmic people and is attended by no signs. **Bony** degeneration is of extremely rare occurrence, but cases have been recorded where minute scales of bone have been found embedded in the coats of arteries. The condition is, however, of too uncommon occurrence to require further notice. **Lardaceous** degeneration of the viscera appears to begin, as I have already pointed out, in a degeneration of the coats of the smaller arteries of the affected organ, and from this spreads to the other structures of the viscus (see page 120).

ANEURISM

An **aneurism** may be defined as a sac containing blood and communicating with the interior of an artery; so that in every aneurism, if the term is correctly used, there must be a sac wall inclosing a space, this cavity or space must communicate with an artery, and it must contain blood, either fluid or coagulated. Aneurisms may result either from injury or disease. The former, which are called traumatic, we have already considered: and we have now to describe the latter, which are termed idiopathic, spontaneous, or pathological aneurisms.

Causes.—An idiopathic aneurism is formed when, from any cause, one or more of the coats of an artery become permanently expanded by the pressure of the blood within the vessel. Therefore there are two factors in the production of an aneurism: (1) a weakening of the wall of the vessel; for normally the coats of an artery are sufficiently strong and elastic to withstand any amount of blood pressure which can be brought to bear on them; and (2) an increase in the blood pressure. So that it may be stated that an aneurism is generally caused by anything which renders the wall of the artery unfit to resist the pressure of the blood in it, and that this is in many cases supplemented by increased blood pressure, from, it may be, increased action of the heart, or plethora, or increased resistance in the capillaries.

1. **Causes which weaken the walls of the vessel.**—When an artery has undergone any of the inflammatory changes described in the last section, its walls become weakened, and thus unable to withstand the pressure of the blood within the vessel, and so become permanently dilated and an aneurism results. Chronic endarteritis is the most potent cause of aneurism. As we have seen, this inflammatory condition affects primarily and principally the elastic coat of the artery, and when it is established the normal elasticity of the vessel is considerably impaired or altogether lost, and the vessel weakened, so that it is no longer able, during diastole, to recover the expansion which has taken place during systole, and thus becomes permanently dilated either throughout its whole calibre or in one spot, where from a patch of atheroma the elasticity has been destroyed; and this may take place in one or more situations (fig. 92). Again, other forms of inflammation of the coats of an artery lead to weakening and expansion, and so to the formation of an aneurism. (*a*) The inflammation of the coats of an artery which is set up by a septic embolus, impacted in the vessel, is

probably the sole cause of aneurism in young people. (*b*) Inflammation of the coats of an artery exposed in an abscess cavity may lead to aneurism. This is occasionally seen in vomicæ of the lung, and by some is believed to be due to the loss of support occasioned by absorption of the surrounding tissues, but is more probably due to inflammatory changes set up in the walls of the vessels as a consequence of direct extension from the inflammation in the tissues around, which weakens them and causes them to yield under the influence of blood pressure. (*c*) Syphilitic arteritis may also lead to aneurism. We have already stated that this disease principally affects the small arteries, and especially the cerebral arteries, and it is in these vessels that aneurism, the result of syphilis, is usually seen. Formerly syphilis was credited with being a cause of aneurism in the larger vessels, but more recent investigation has shown that there is no evidence to support this view.

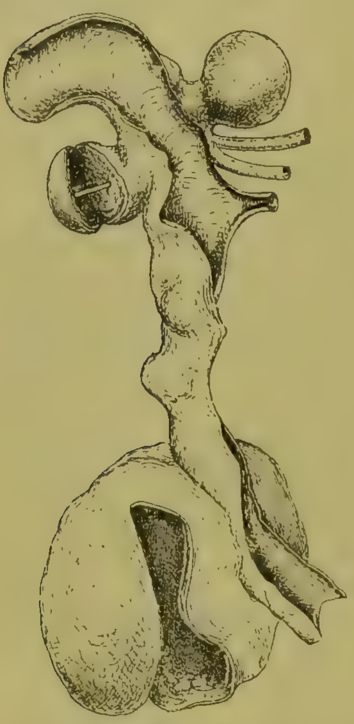

FIG. 92. —An aorta showing several aneurisms in different parts from a diseased condition of the coats of the vessel. (From a preparation in the Museum of St. George's Hospital.)

2. **Causes which increase blood pressure.**—The most common cause of increased blood pressure in relation to the etiology of aneurism is greatly increased action of the heart, of an occasional or intermittent character. It is probable that increased action of the heart which is continuously brought about is not nearly so potent a cause of aneurism as intermittent strain, for we find aneurisms are very common in soldiers and sailors, who are occasionally called upon to make sudden and unwonted exertion, and in people in better circumstances, who most of the year live a sedentary life and then indulge in active exertion, mountaineering, &c., and so put a sudden strain on their circulation; while aneurism is not common in labouring men, who are constantly employed in steady, laborious occupations, and whose heart and vessels accommodate themselves to it. Other causes which increase blood pressure, such as plethora, or the increased arterial tension accompanying arterio-capillary fibrosis, also act as causes of aneurism.

Predisposing causes.—(1) *Age.* Aneurisms are most common at that age when the coats of the arteries are beginning to undergo senile changes and are thus weakened, while the muscular system is still vigorous and the individual engaged in active pursuits. (2) *Sex.* Aneurism is much more common in the male than in the female, and this is what one would naturally expect, since active muscular exercise predisposes to the disease. (3) *Occupation.* As above stated, aneurism occurs most frequently in those who are called upon to make sudden and severe muscular exertion, rather than in those who are continuously employed in hard work. (4) *Climate.* Aneurisms are more common in those who dwell in cold or temperate climes than in those who live in hot countries. This is probably because the inhabitants of these colder regions take more active exercise and are more energetic, and not to any climatic influence. Aneurisms are more common on the right side of the body than on the left, no doubt from the fact that this side is more used, especially as regards the upper extremity in right-handed individuals.

The only **exciting cause** of aneurism is injury, and this injury is generally applied to a diseased artery. It may be a blow, which may cause the lining membrane over an atheromatous patch to give way; or strain, which, in addition to being the cause of the atheroma which leads to aneurism, may also act as the exciting cause of the aneurism by partially lacerating the already diseased artery. There can be little question that one of the causes of the great frequency of popliteal aneurism is strain of the knee joint when the popliteal artery is diseased. Laceration or wound of an artery leads to traumatic aneurism.

Varieties.—Aneurisms may be divided into three different varieties, which differ in their shape, in their nature, and in their mode of origin. These are the (1) Fusiform, (2) Sacculated, (3) Dissecting (fig. 93). The sacculated aneurism is sometimes divided into two: (*a*) the *true*, where all the coats are involved in the sac of the aneurism; and (*b*) the *false*, where only some of the coats are involved. The division, however, is of no practical importance, it cannot be distinguished by any clinical features, and it is only true in quite the early stages of the formation of an aneurism. It is, however, interesting to bear it in mind for a minute or two in considering the way in which these different forms of aneurism originate.

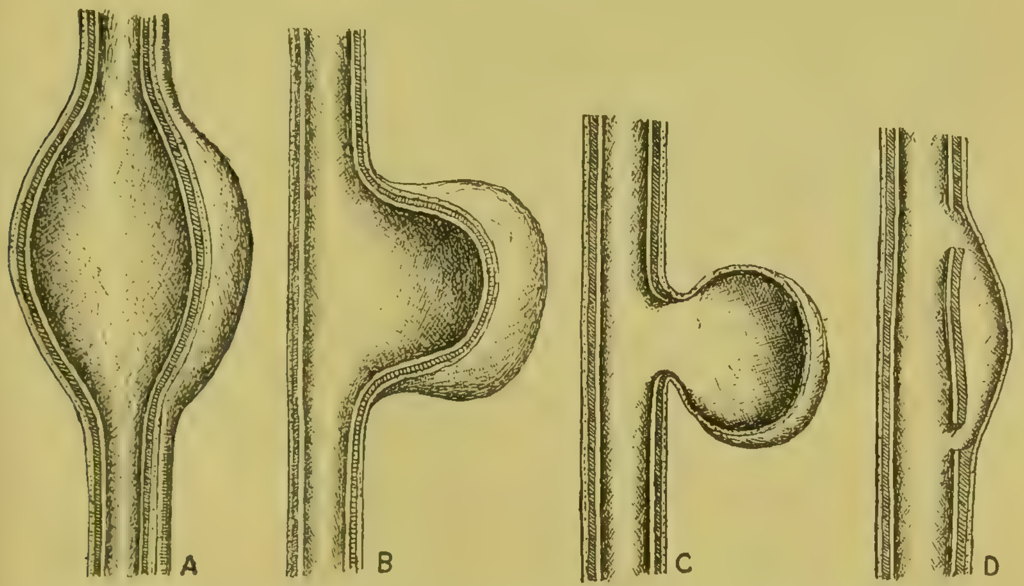

FIG. 93.—Diagram showing the different varieties of aneurism. A, Fusiform aneurism; B, True sacculated aneurism; C, False sacculated aneurism; D, Dissecting aneurism.

A **fusiform** aneurism is a dilatation in all directions of the entire circumference of an artery, so that the capacity of the vessel is increased, and it is also elongated (fig. 93, A). It most frequently occurs in the arch of the aorta, and its mode of origin can best be explained when considering it as it affects this vessel. The artery first becomes the seat of chronic endarteritis, which affects principally the elastic tissue of the intima, and in consequence of this the elasticity of the vessel is impaired. When the ventricles contract, the left one pours a volume of blood into the aorta, which expands under its pressure. In the healthy condition the elastic tissue now comes into play, and by virtue of its property of elasticity contracts the vessel to its original dimensions, and drives the blood onwards in the course of the circulation. But if the vessel is diseased, and the elasticity is impaired, this return to the natural condition of the vessel is not quite complete, and so a little permanent dilatation is produced; this goes on increasing until in the end a fusiform aneurism is produced. The same process goes on in the larger arteries when they are diseased, and it is in them that fusiform aneurisms are found next in frequency to those in the arch of the aorta; such vessels as the descending aorta, the iliacs, and the innominate. These aneurisms are also sometimes found in the common femoral, the subclavian, and the carotid arteries.

Sacculated aneurism.—By a sacculated aneurism is meant one which grows from the side of an artery, and communicates with it by a more or less constricted aperture. It is formed, therefore, by the dilatation of a part of the circumference of an artery. We have said that sacculated aneurisms are divided into two classes, the true and the false. The mode of origin of the two is somewhat different. In the *true* aneurism a patch of atheroma, generally of a considerable size, occurs on some part of the circumference of a vessel, and destroys the elasticity of the vessel at this spot; in consequence of this it yields to the pressure of the blood, and the whole wall of the vessel becomes dilated in one place only, and a true sacculated aneurism results (fig. 93, B). This condition only exists during the earlier stages of the formation of the aneurism, for very soon the internal and middle coats disappear, and can no longer be recognised, and the aneurism becomes now a false one, in which all three coats are not present. It follows from this that the true sacculated aneurism when it exists is always of small size, and has a large orifice of communication with the parent vessel. The *false* sacculated aneurism is formed in a somewhat different way. Here also it commences as a patch of atheroma, but this patch, instead of simply weakening the vessel, and so causing it to dilate, goes on to those degenerative changes of which we have spoken, to the formation of an atheromatous abscess, and then, by rupture or giving way of the thin covering of the abscess, and the discharge of its contents into the blood stream, to the formation of an atheromatous ulcer. We have now a little excavation or abrasion on the vessel wall, into which the blood during its passage down the vessel finds its way, and by pressure causes dilatation of the external coat and any remains of the middle coat which may still be present, and so forms a false sacculated aneurism, or one in which the sac wall is not formed by all the coats of the vessel (fig. 93, C). The coats of the vessel around the eroded patch become matted together, so as to prevent the blood, which finds its way into the excavation, from being forced between the different coats of the artery. If this matting does not take place, the third variety of aneurism, the dissecting, is formed, as we shall explain directly. It must be mentioned that by some surgeons the terms true and false sacculated aneurism are used to imply a different condition. They apply the term true aneurism to those cases where the sac of the aneurism is formed of one or more of the coats of the vessel; and false to those in which some part, at all events, of the sac of the aneurism is formed by condensed connective tissue derived from the structures around. But in whichever way the two terms 'true' and 'false' as applied to aneurism are employed, it is a matter of no practical importance, and the mere fact that these terms are applied differently by different people is an additional argument, if any were needed, for giving them up entirely.

The **dissecting** aneurism is formed in those cases where the tissues forming the margin of an atheromatous ulcer are not matted together, and where the blood, therefore, finds its way between the coats of the vessel, so that the sac of the aneurism is formed within the wall of the vessel (fig. 93, D). These cases are very rare.

It will be now necessary to consider these different varieties of aneurism a little more in detail.

A **fusiform** aneurism is a dilatation and elongation of an artery, accompanied by degeneration and thickening of its wall. It is, as its name implies, fusiform in shape as regards its general outline, but in many cases this fusiform shape presents irregularities or bulgings, where the arterial wall has yielded in some places more than in others. It is characterised by having two openings, one of entrance and the other of exit, by which it may be at once recognised from a sacculated aneurism, which has only one opening. A fusiform aneurism is formed by all the coats of the vessel, and in its earlier stages all these coats form a perfect investment for the sac. As, however, the aneurism increases in size the middle coat becomes thinned, from degeneration of the muscular fibres, and after a time gaps are found where the muscular coat is entirely wanting, and sometimes in very old and large fusiform aneurisms almost all trace of muscular tissue is lost. The inner coat is very uneven and irregular on its surface, and often presents plates of calcareous material and other evidences of atheromatous change. Here and there shreds of fibrin may be seen adhering to it, but there is no deposit of laminated fibrin, such as will be described as occurring in the sacculated aneurism. The external coat is much thickened, by the formation in it of a dense fibroid material; this supports the pressure of the blood within the sac and prevents the increase in the size of the aneurism taking place very quickly, so that the life history of a fusiform aneurism is essentially chronic. It begins insidiously, very often giving rise to few or no symptoms; it progresses very slowly, and may often remain stationary for a considerable time, or it may gradually increase and may eventually attain a great size and prove injurious by causing pressure on surrounding structures, and tends eventually to destroy the life of the patient. This it may do in several different ways. It does not often burst as long as it remains distinctly fusiform, but it is no uncommon occurrence for a fusiform aneurism to develop a sacculated aneurism upon it by a yielding of its coats at one spot, and this frequently terminates the existence of the patient by bursting. Fusiform aneurisms of the ascending portion of the arch of the aorta are, however, liable to burst into the pericardium and destroy the patient. This appears to be due to the fact that less growth of fibrous tissue in the external coat takes place in this situation than elsewhere. Fusiform aneurisms may sometimes burst into important parts, such as one of the bronchi or the œsophagus. Death may also occur from the weight of blood in an aneurism of the aorta overpowering the heart's action and producing fatal syncope, or from the dilatation of the aorta causing incompetence of the valves and leading to fatal regurgitation.

Sacculated aneurism.—A sacculated aneurism is formed by the dilatation of a part of the circumference of an artery, and may vary in size from a marble to a cocoa nut or even larger. In whichever of the two ways it is formed, it cannot increase to any appreciable extent without great changes taking place in its coats, which result in the sac wall being formed of the external coat only, and even this undergoes such changes that after a time very little or no remains of the original tunics of the vessel exist, and the sac wall becomes practically a new formation of fibrous tissue. When the aneurism, in the first instance, is formed of all three coats of the vessel, the inner coat soon gives way, and the muscular coat undergoes fatty degeneration and disappears, and nothing is left but the outer coat, so that we have the same condition as where the two inner coats have been destroyed by atheroma before the formation of the aneurism. The outer coat becomes much thickened, both on its outer and inner surfaces, by a growth of new fibrous tissue; that on the outer surface being caused by a chronic periarteritis, which is set up in the sheath as a result of the pressure of surrounding parts on the sac; that inside is formed from the organisation of clot which forms on the interior of the sac. With these two layers of new tissue the outer coat becomes incorporated and gradually disappears; at all events it becomes indistinguishable from the new fibrous tissue which forms the envelope of the sac.

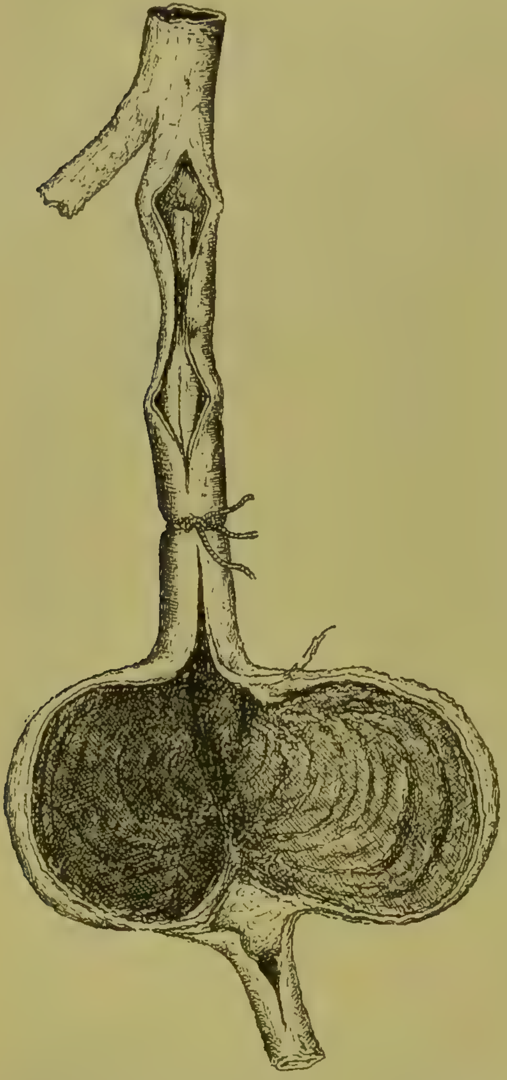

FIG. 94.—An aneurism completely filled with fibrin, which has been deposited in laminæ. (From a preparation in the Museum of St. George's Hospital.)

The contents of a sacculated aneurism during life consist of arterial blood, with a varying amount of fibrin applied to the wall of the sac. This fibrin is of a pale buff colour, and is arranged in the form of laminæ, which are superimposed one on the top of another, like the layers of an onion. The amount of this laminated fibrin varies: in some instances it may completely fill the sac, and occlude the vessel opening into it, and then the aneurism is said to be cured (fig. 94); in other instances it may form a thick layer partially filling the sac, and then it will be found that the more superficial layers, and therefore the last formed, are softer and more coloured than the deeper parts; in some sacculated aneurisms there may be only a small amount of partially decolourised fibrin clinging to the interior of the sac. The laminated fibrin is formed in the following way: in consequence of the changes which have taken place in the intima this structure acts as a foreign body and attracts the leucocytes, and owing to this cause and to the slowing down of the blood current as it flows through the sac, the leucocytes adhere to its interior. Some of these disintegrate and set free their fibrin-ferment, which acting on the fibrinogen in the blood causes the formation of a layer of fibrin on the interior of the sac. A repetition of the process determines the concentric laminæ which tend to fill up the aneurism, and eventually to cure it, if the process proceeds sufficiently far. This laminated fibrin was named by Broca *active clot*, and can only occur when the blood is in motion in the sac. If from any cause the circulation through an aneurism is completely arrested, the blood in the sac coagulates, and in doing so entangles in the meshes of fibrin the red corpuscles, producing an ordinary blood clot, similar to one formed when blood is withdrawn from the body and allowed to stand. This was termed *passive clot* by Broca. Between these two extremes are many gradations, and therefore clots of various degrees of colour may be produced, so that it is possible that, as is believed by some, the laminated fibrin or active clot is merely passive clot, which has been altered from the pressure to which it is exposed. These observers explain the presence of the various layers found in the interior of an aneurism in the following way. Coagulation of a certain amount of blood first takes place in some part of an aneurism which is not exposed to the full current, and therefore where there is time for the clotting process to take place. This clot is then subjected to pressure from the blood in the aneurism, and becomes flattened out and pressed against the interior of the sac. Here it becomes altered in appearance, first by the serum being squeezed out of it, then by the red corpuscles contained in it becoming disintegrated, and it thus becomes decolourised and forms a layer, which is in fact a lamina of colourless fibrin.

The formation of laminated fibrin on the interior of an aneurism is a matter of the utmost importance. In the first place, it is nature's mode of curing an aneurism; and when the surgeon takes the treatment of aneurism in hand, he endeavours to assist nature by such means as will induce coagulation to take place in the sac. In addition to this the clotting in the cavity of an aneurism strengthens its walls and prevents the too rapid increase of the tumour, and lessens the capacity of the sac and thus diminishes the pressure on the parts around, for the distending force of the aneurism is proportional to the size of the sac.

Dissecting aneurism is that form of aneurism where the sac is formed within the wall of the vessel by a separation of its coats from each other. It occurs in those cases where an atheromatous ulcer has formed on the inner coat; but in consequence of no adhesion having taken place between the tissues around the patch, the blood, instead of dilating the remains of the coats on the floor of the ulcer and so forming a false sacculated aneurism, gradually burrows its way between the coats, separating hem from each other. It is usually taught that the blood burrows its way in the substance of the middle coat, which is softer and more easily acerable than the others, and it may extend for a very considerable distance, n some cases throughout the whole length of the descending aorta. It is n this vessel only that the disease has been described as occurring. The blood after passing downwards for a variable distance usually bursts through he outer coat of the artery, and the patient dies of hæmorrhage; but in arer instances it finds its way back again into the natural channel. This occurs when there is a softened patch of atheroma in the vessel below the point where the blood first found its way between the coats; when it meets with this it readily makes its way back into the artery (fig. 93, D). This condition is not incompatible with life, and presents the appearance on post-mortem examination of a double channel. It used to be described in the older works on surgery as a double aorta. Again, in some cases the blood after extending a certain distance does not separate the coats any farther, and a sac is formed in the substance of the middle coat, into which the blood finds an entrance and an exit through the same opening. It may thus remain stationary for a considerable time, but eventually the external coat usually gives way and death takes place from hæmorrhage.

Dissecting aneurisms are said to be more common in women than in men, and to occur in cachectic individuals. They are rarely, if ever, diagnosed during life. The only known symptoms are those which occur at the moment of their formation; the patient becomes collapsed and faint, complains of intense sudden pain along the course of the aorta, and this is accompanied by diminution in the pulse in the lower extremities. These symptoms occurring in a patient with marked atheromatous disease might lead the surgeon to suspect a dissecting aneurism. There is no treatment for this condition.

Progress and termination of aneurism.—When once an aneurism has formed, it is likely to go on increasing as long as the conditions subsist which gave rise to it; but if the pressure of the blood which tends to increase it is exactly counterbalanced by the thickening of the sac and consolidation of surrounding parts, and the consequent increased resistance to the pressure, an aneurism may remain stationary for a long time. As a matter of fact, this balance is rarely maintained, and an aneurism either undergoes continuous enlargement or spontaneous cure.

When continuous enlargement takes place the aneurism usually ruptures, or more rarely suppurates, unless it proves fatal before these terminations are arrived at, from its pressure effects or from syncope, as is often seen in aneurisms of the arch of the aorta.

Rupture of aneurism.—When occurring within one of the cavities of the body an aneurism may cause sudden death from loss of blood, by bursting into one of the serous cavities or mucous tracts; or from asphyxia in the case of an aneurism bursting into the air passages. Internal aneurisms may also reach the surface of the body and burst externally. Thus an aneurism of the arch of the aorta may cause erosion of the ribs or costal cartilages and appear as a tumour on the front of the chest, and may then burst externally and cause the death of the patient from hæmorrhage. External aneurisms may rupture either on the surface of the body or into the interior of a limb, giving rise to a *diffused aneurism*. When it occurs on the surface of the body it is not always immediately fatal, since the opening often becomes plugged with a mass of coagulum. As this becomes displaced or gives way hæmorrhages occur, sometimes in small quantities, and then in consequence of replugging it is again arrested. These cases, however, eventually prove fatal. When an aneurism gives way in the interior of a limb the blood which is effused may be partially circumscribed by the tissues into which it is infiltrated, and under these circumstances a diffused aneurism is said to have taken place; or it may be widely diffused through the whole limb and speedily end in gangrene. When a diffused aneurism is formed the case usually terminates by gradual increase of the swelling until it reaches the surface of the body and ruptures, or in gangrene. Suppuration of an aneurism is not of common occurrence. It may begin either outside or inside the sac. In the former case it occurs after ligature; the wound becomes septic, and if the aneurism is situated in loose and yielding tissues, as in the axilla, the structures around the sac and the sac itself become involved. When the suppuration takes place in the sac, it is generally in consequence of the aneurism having ruptured into the tissues by a small opening. The presence of the blood in the tissues around causes inflammation, and the presence of pyogenic organisms determines the suppuration, which secondarily affects the blood in the sac. The symptoms of this condition are those of acute inflammation and abscess. The swelling points and, if left alone, bursts and gives exit to a quantity of pus, mixed with broken-down coagula. This may be followed by a fatal gush of blood, or no hæmorrhage may occur at the time of bursting because the orifice in the artery is plugged with a thrombus; this may subsequently become loosened and bleeding occur, or if, as occasionally but rarely happens, it remains permanently fixed, the cavity becomes closed like an ordinary abscess.

Spontaneous cure of an aneurism.—The spontaneous cure of an aneurism is of very uncommon occurrence, though, as we have already seen, in all sacculated aneurisms there is a tendency to this spontaneous cure by the deposition of laminated fibrin on the surface of the sac. This tendency is brought about by the alteration in the internal surface of the aneurismal sac, which favours the adhesion of the leucocytes to it, and by the diminution in the circulation through it, which is caused by the contraction in the artery below the sac. But something more than this is necessary to complete the process of spontaneous cure, and two or three conditions are usually regarded as the means by which this end is attained: (1) By the partial blocking of the mouth of the sac with a piece of detached clot. (2) By a piece of clot from the aneurismal sac being carried into the vessel below, and becoming impacted there. (3) By the pressure of the aneurism on the vessel above narrowing its lumen, and obstructing the flow of blood through it. (4) Plastic arteritis may, it is said, seal the vessel above and below the sac, this being set up by inflammation in the tissues around.

Pressure effects of an aneurism.—The pressure which an aneurism exerts on surrounding parts is very considerable, and is a matter of great moment, not only on account of the changes which it produces in these structures, but also because it constitutes an important factor in the diagnosis of these cases. One of the most constant results of pressure is to excite an inflammation in the tissues around; this is attended by the effusion of inflammatory products which mat the structures together, and materially strengthen the sac of the aneurism, and prevent its increase in size. In this respect the pressure exerts a beneficial influence, but in other respects it exerts a prejudicial influence. When it presses on veins, as it so often must do on account of its proximity to them, it tends to occlude them, and obstruct the circulation of blood through them. In consequence of this there is œdema of the parts below, and very often a varicose condition of the superficial veins. Occasionally a communication may be established between the aneurismal sac and the lumen of the vein. Neighbouring arteries may also be pressed upon, and the circulation through them interfered with; or a communication may be established between the sac and the artery on which it presses. Cases have been recorded where this has taken place in an aneurism of the thoracic aorta communicating with the pulmonary artery. Nerves when pressed upon become flattened out and ribbon-shaped, and undergo degenerative changes (fig. 95); this may lead to pain radiating along the course of the nerve compressed, or to paralysis of the muscles supplied by it, or to modification of function. When bones are pressed upon by an aneurism they become absorbed without any signs of inflammation. The sternum may be completely perforated by a thoracic aneurism, and the tumour point externally. The bodies of the vertebræ are also frequently absorbed by the pressure of an aneurism of the aorta. The cartilages are more resisting, so that it frequently happens in examining the spine in a case in which an aneurism has been pressing upon it that the bones will be found to be extensively absorbed, while the intervertebral discs stand out between the eroded vertebræ almost unaltered. Muscles and fascia are thinned, and then absorbed, or may become more or less blended with the condensed tissue around the sac. Glands and their ducts when pressed upon may have their functions impaired, or the passage of their secretion arrested, and respiration or deglutition may be impeded by pressure on the trachea or œsophagus.

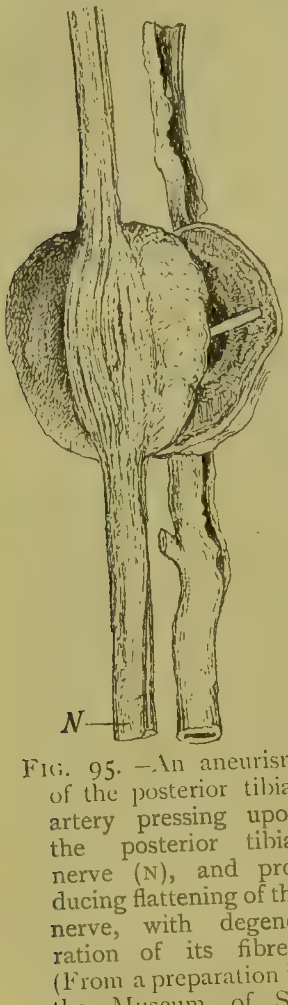

FIG. 95.—An aneurism of the posterior tibial artery pressing upon the posterior tibial nerve (N), and producing flattening of the nerve, with degeneration of its fibres. (From a preparation in the Museum of St. George's Hospital.)

Signs of external aneurism.—The first and essential sign is the presence of a tumour in the course of a large artery. The tumour may vary in size, but it is always circumscribed, is usually globular in shape, and is fixed to the artery, from which it springs, and from which it cannot be moved. It varies in its consistence: when superficial and containing little laminated fibrin, it is soft and compressible, and may fluctuate; when more deeply seated or containing more clot, it is firmer, and more solid to the touch. The tumour pulsates, and the pulsation is of that peculiar character which is known as *expansile*; that is to say, the tumour expands in every direction, becoming larger and more tense with each beat of the heart. This expansile character of the pulsation is best appreciated by placing the tips of the fingers on the swelling, when at each beat of the heart the fingers will be noticed to become separated from each other, as well as raised. In a tumour situated over an artery, but not connected with it, the pulsation is a simple upheaving, and though the fingers placed on the tumour are raised they are not separated from each other. When a stethoscope is placed on an aneurism a bruit in most cases will be heard. This is due to the blood rushing into and out of the sac, and is sometimes double. It varies much in intensity and character, but is usually blowing, and accompanies the systole of the heart. In some cases also a thrill may be felt over the tumour, caused by the rush of blood into the sac at each heart beat.

If the aneurism is superficial and contains only a small amount of clot, pressure on the artery above, so as to arrest the circulation through the sac, will occasion shrinking and diminution in tension in it, and by a little pressure the tumour may be still further diminished. If now the pressure is removed from the vessel above, the sac will again expand, and in two or three beats will regain its original size. The pulse in the limb below the swelling is smaller than on the sound side and is somewhat delayed. A sphygmographic tracing (fig. 96) shows the pulse to be much less abrupt in its rise, and to be more rounded. The pain of an aneurism varies very much. In many cases a deep boring, burning pain is complained of in the part, due to inflammatory conditions in the tissues around, and to the tension to which the parts are subjected. Where bones are pressed upon and are becoming absorbed, the pain is often of a peculiarly excruciating character. In addition to this there is often pain complained of in the peripheral terminations of any nerves which may be pressed upon by the tumour. In consequence of pressure upon the vein accompanying the artery on which the aneurism is situated, there is very often œdema of the parts below, and a varicose condition of the superficial veins.

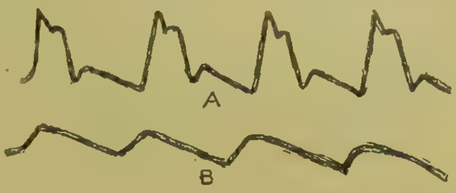

FIG. 96.—Sphygmographic tracing of the radial pulse on the two sides of the body, from a case of subclavian aneurism. A, Normal tracing; B, Tracing on affected side.

The **diagnosis** of external aneurism is usually simple, and in most cases it is comparatively easy to avoid errors in diagnosis; but, at the same time, it must be admitted that in some cases the diagnosis is very difficult, and this is still more so with internal aneurisms where there is often no bruit, and where no pulsation can be felt, and where indeed there are often no symptoms except those produced by pressure. An aneurism may be mistaken for a solid or cystic tumour lying near an artery and deriving pulsation from it; such, for instance, as a cystic bronchocele deriving pulsation from the carotid or innominate artery, or an enlarged bursa in the ham deriving pulsation from the popliteal; but attention to the essential features enumerated above ought to prevent the surgeon from falling into error in these cases.

The fact that these tumours do not diminish in size when the circulation is arrested in the vessel above; that there is no expansile pulsation—merely the up and down movement communicated to them by the artery beneath them; and that they can usually be displaced from the artery, when all pulsation ceases, is sufficient to establish the diagnosis. But it is in cases of malignant tumours growing from bones that the greatest difficulty is experienced. These often contain large spaces filled with blood, and pulsate on account of their great vascularity. In addition to this, they occasionally have a bruit, and lie in exactly the situation of a large artery. But in most cases the expansion of the bone may be detected, and the increase of the tumour at each pulse wave is much less in proportion to its size than in aneurism; as well as the decrease when the circulation in the artery above is arrested. No doubt also a skiagraph taken with the Röntgen rays would materially assist in the diagnosis.

When an aneurism ruptures and becomes diffused, the patient experiences a sudden intense pain in the part, and is more or less collapsed—cold, pale, and faint. The tissues around are much swollen, and the tumour loses its circumscribed outline. The limb below is cold and livid, and there is a sensation of weight and numbness about the part, and no pulsation can be felt in the vessels below the seat of the aneurism. The swelling will probably in most cases rapidly increase in size, and eventually gangrene of the limb will ensue. When an aneurism suppurates the signs are to a very considerable extent similar to those of diffusion; that is to say, there is rapid increase in the swelling and loss of the circumscribed outline of the tumour, due in this instance to inflammatory œdema in the tissues around the sac, and the pulsation and bruit are less apparent; but in cases of suppuration the parts are acutely painful, red, hot, and pitting on pressure, and there is evidence, by the increased temperature, of constitutional disturbance. In addition to this the circulation in the limb below is but little interfered with.

Treatment of aneurism.—In treating an aneurism the surgeon should endeavour as far as possible to use such measures as will assist nature in her efforts to cure the disease. We have already seen that spontaneous cure is brought about either by the formation of successive layers of laminated fibrin deposited on the internal surface of the sac, gradually filling it up; or by coagulation of the blood in the sac of the aneurism and its subsequent organisation; but, as originally pointed out by Scarpa, this filling up of the aneurism by clot and its subsequent organisation can only be brought about by the obliteration of the artery from which the aneurism springs, so that though the filling of the sac with clot, which is the first stage of the process and the one which the surgeon aims at bringing about, is essential to the 'cure,' still it is not the whole of the cure, for unless this clot becomes organised, much in the same way that a thrombus in an artery is organised, and the aneurism converted into a mass of fibrous or scar tissue, the cure cannot be regarded as complete, and as long as the artery communicating with the aneurism is pervious, the impact of blood flowing through it prevents this organisation from occurring.

The means which the surgeon adopts in order to promote the formation of clot, either *active* or *passive*, in the sac of an aneurism are three: (1) by lessening the force of the circulation through the aneurism; (2) by increasing the coagulability of the blood; and (3) by directly causing the blood in the sac to coagulate. And this may be done by (*a*) constitutional or (*b*) local means.

a. **Constitutional treatment.**—The constitutional measures which are employed in the treatment of aneurism aim, first and principally, at reducing the tension in the aneurism and thus favouring coagulation, and, secondly, at increasing the plasticity of the blood. Two somewhat different plans of treatment are in vogue in order to bring about these objects: these are known respectively as Tufnell's and Valsalva's methods of treatment. Tufnell's plan consists in lessening the force of the heart by absolute and perfect rest, and reducing the quantity of the blood by a dry and restricted diet, and at the same time increasing its plasticity by the administration of iodide of potassium or acetate of lead. He enjoined that the rest should be as absolute as possible, both mental and physical: the patient should never be allowed to leave his bed or assume the erect position; he should be allowed to transact no business or be engaged in any conversation, or read any books which would excite him; the diet should be spare in quantity but nourishing in quality, and fluids restricted as much as possible; and finally that the patient should have administered to him iodide of potassium or acetate of lead. The diet recommended by Tufnell is as follows: Bread and butter, 4 ozs.: meat, 3 ozs.; potatoes, 3 ozs.; fluid, 8 ozs.; in the twenty-four hours. With regard to the value of the drugs in the treatment of aneurism considerable difference of opinion exists. As far as my own personal experience goes, the only good effect that I have been able to trace to them is that, somehow or other, iodide of potassium seems to have an undoubted beneficial effect in relieving the pain of aneurism.

Valsalva's plan aimed at gradually diminishing the quantity of blood in the system, and reducing the force of the heart, and so the pressure on the walls of the aneurism, and, when this had been done, increasing the plasticity of the blood by gradual and careful feeding. The first of these aims he accomplished by a gradual reduction of the food day by day, until it was lowered to the smallest quantity compatible with life; by subjecting the patient to frequently repeated small bleedings; and by the administration of saline purgatives. When by this means the patient had been reduced to the lowest ebb, so that he could not be raised in bed without fainting, he was gradually built up again by careful and judicious feeding, and by no longer having recourse to the bleeding and purging. It is seldom that the plan of treatment recommended by Valsalva is adopted in its entirety by surgeons in the present day, but in a somewhat modified form either this plan or Tufnell's, or a modified combination of the two, may be usefully employed in those cases of aneurism where no local measures can be adopted.

b. **Local treatment.**—The local or surgical methods of treating aneurism are very various, for in addition to the two principal methods, (1) compression and (2) ligature, many others have at different times been recommended and resorted to, such as (3) excision; (4) manipulation; (5) introduction of coagulating agents; (6) galvano-puncture; (7) injection of ergotin; (8) acupuncture; and (9) introduction of foreign bodies. We shall first discuss the two principal measures, and then briefly refer to these other means of bringing about the cure of an aneurism.

1. **Compression.**—The object of pressure as now employed is either to entirely or partially arrest the flow of blood through the sac of the aneurism, and so produce consolidation either by the formation of an ordinary clot or by the deposit of laminated fibrin. Up to quite recent times this plan of treatment was always resorted to, when possible, before any attempt was made to cure the aneurism by ligature of the artery. Before the introduction of aseptic surgery, the risks of ligature from secondary hæmorrhage and other septic processes was so great, that surgeons hesitated to resort to an operation involving an open wound until all other measures had been fairly tried and failed. But there is, I think, a growing feeling in the minds of surgeons that, in many cases at all events, they will be best consulting the welfare of their patients by at once resorting to ligature in cases of aneurism, without attempting to treat it first by pressure: for by this means they are more certain of effecting a cure, and this with no greater risk to the patient than is entailed by compression. Moreover, after long-continued pressure the collateral vessels enlarge, and ligature of the main artery has therefore less effect on the blood pressure in the aneurism, since blood finds its way into it through these enlarged collateral vessels; the prospect, therefore, of effecting a cure by ligature is lessened if long-continued compression has been resorted to previously. Still, at the same time, it must be confessed that the treatment by compression is attended by a considerable measure of success, and there are many cases of aneurism in which it is still right to resort to this mode of treatment.

There are many ways of applying compression, of which the following are the principal: (*a*) digital; (*b*) instrumental; (*c*) distal; (*d*) direct; (*e*) flexion; (*f*) Esmarch's bandage.

(*a*) **Digital pressure,** where it can be applied, is no doubt theoretically the best way of applying pressure, but it is exceedingly difficult to carry out satisfactorily. The plan consists in compressing the artery on the proximal side at some distance from the sac with the fingers. This is an exceedingly tiring proceeding, and a large artery can scarcely be compressed for a longer period than ten minutes, and therefore a relay of assistants is required, and a change of the compressor has to be made at short intervals. With every care during the process of changing, a little blood is apt to find its way through the artery, and the sac refills. Or, again, the compressor's fingers becoming tired, he involuntarily relaxes his pressure for a moment, or his attention becomes diverted and the same thing happens, and thus the pressure becomes irregular, and this constant refilling of the sac, though only for a moment, causes perpetual disturbances in the contents of the sac, which prevent the necessary coagulation taking place. The advantages that are claimed for this mode of treatment are that it is less painful, that the artery can be compressed without interfering with the venous circulation, and that there is less chance of damaging the tissues, and no doubt these are very sound and solid advantages, so that if digital compression is carried out with care and attention to detail, it is undoubtedly an excellent mode of applying pressure in the cure of aneurism. The principal points to be borne in mind are: First, that the artery must be compressed where it lies over a bone, otherwise efficient pressure cannot be made, therefore the only arteries available for this plan of treatment are the common carotid, the subclavian, the axillary, the brachial, and the common femoral. Secondly, that the pressure should be just sufficient to stop all pulsation in the sac of the aneurism, and not sufficient to cause any damage to the compressed tissues; a second assistant should always, therefore, be told off to keep his hand on the aneurism, and regulate the amount of pressure by noting its effects. Thirdly, in changing the compressor, care should be taken that the artery does not escape even for a moment; the artery should be controlled by the fresh man before the weary one relaxes his pressure. Digital compression may be very materially assisted by placing a weight or bag of shot on the fingers or thumb of the person compressing the artery, and in this way the pressure may be maintained by one man for a longer period without undue fatigue. The time required to cure an aneurism by this means varies very much; cases have been recorded in which cure has been effected in 1½ to 3 hours, but it is said that the average time is three days.

(*b*) **Instrumental compression** is carried out by various forms of tourniquets, which are arranged in such a manner as to compress the artery without interfering with the circulation in the rest of the limb. The accompanying figure of some of the different forms of tourniquets in use will give a better idea of their mechanism than any mere description in words (fig. 97). Of these probably Carte's is to be preferred, as the force is regulated by an elastic band, by which the pad is connected to the rest of the instrument. Another means by which instrumental pressure can be made, and which is especially adapted to compression of the common femoral in the groin, is by a conical graduated weight (fig. 98). The end of this weight should not be much larger than the finger, in order to avoid as far as possible compressing the vein at the same time. It is simply held by an assistant, and great care must be observed to maintain it over the artery constantly, as the slightest movement on the part of the patient has a tendency to displace it. Instrumental pressure is not so good as digital, since it is more painful and is more apt to be followed by galling or even sloughing of the skin: but it possesses this advantage, that it can be applied in some situations, as to the aorta, where digital pressure cannot be employed.

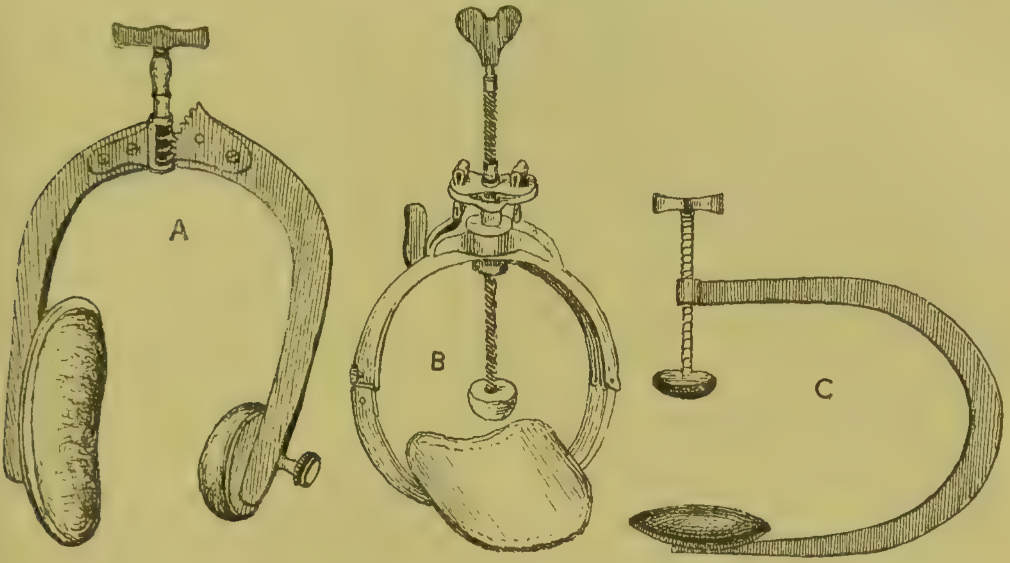

FIG. 97.—Tourniquets. A, Signoroni's tourniquet. B, Carte's tourniquet for compressing the femoral artery. C, Lister's aorta compressor.

(*c*) **Distal pressure** has sometimes been recommended in cases where proximal pressure is not possible, as in aneurisms of the abdominal aorta.

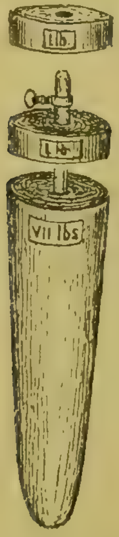

FIG. 98.—Graduated weight for compressing the common femoral artery in the groin.

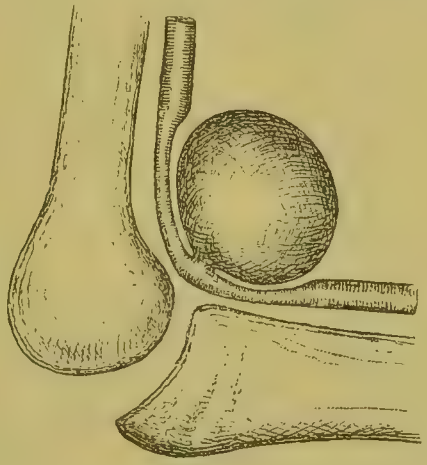

FIG. 99.—Diagram to illustrate the mode of treating a popliteal aneurism by flexion: by flexing the tibia on the femur the sac of the aneurism is made to press on the vessel above and below, and so narrows the lumen of the tube and retards the flow of blood through it.

It has also been employed by some as an adjunct to proximal pressure. Cases have been recorded which prove that instrumental pressure on the distal side of an aneurism is enough to bring about its cure, and therefore this mode of treatment may be regarded as justifiable where no other plans of treatment are available.

(*d*) **Direct pressure** has also succeeded in curing aneurisms, but is very uncertain in its action. It is best applied by means of a bag of shot placed over the aneurism, which can be varied in size according to the effect it produces. This plan of treatment is especially applicable to aneurisms of the third portion of the subclavian artery, and I have seen a case cured by this means.

(*e*) **Flexion** consists in flexing the limb so as to cause the aneurism to press on the vessel above, and thus retard the flow of blood through it (fig. 99). In this respect it acts in the same manner as that in which spontaneous cure is sometimes brought about by the pressure of the aneurism on the vessel. It is, of course, only applicable to those cases where the aneurism is situated opposite the flexure of a joint, and has been especially used in popliteal aneurism. It has also been used in the treatment of aneurism at the bend of the elbow, and has been tried in femoral aneurism.

(*f*) **Esmarch's bandage.**—This plan of treatment, which was introduced by Staff Surgeon Reid for the cure of popliteal aneurism, differs from all other modes of compression, inasmuch as it entirely arrests the circulation of blood in the part for a time. It aims at producing coagulation of blood in the sac and in the adjacent artery, in the hope that the clotted blood may subsequently organise. The way in which it is employed is first to anæsthetise the patient, and then bandage the limb with the elastic bandage from the fingers or toes upwards until the site of the aneurism is reached. The bandage is to be applied with a fair degree of firmness. When the tumour is reached the bandage is carried very lightly over it, or the tumour is missed altogether, and the limb bandaged firmly for a short distance above. The bandage should never be allowed to remain on for a longer time than an hour and a half, which is the outside limit. When it is removed light pressure should be kept up on the main artery of the limb for two or three days to prevent displacement of the soft clot in the artery and sac. Many cases have been recorded as having been cured by this method, which possesses the advantages of being both simple and rapid;

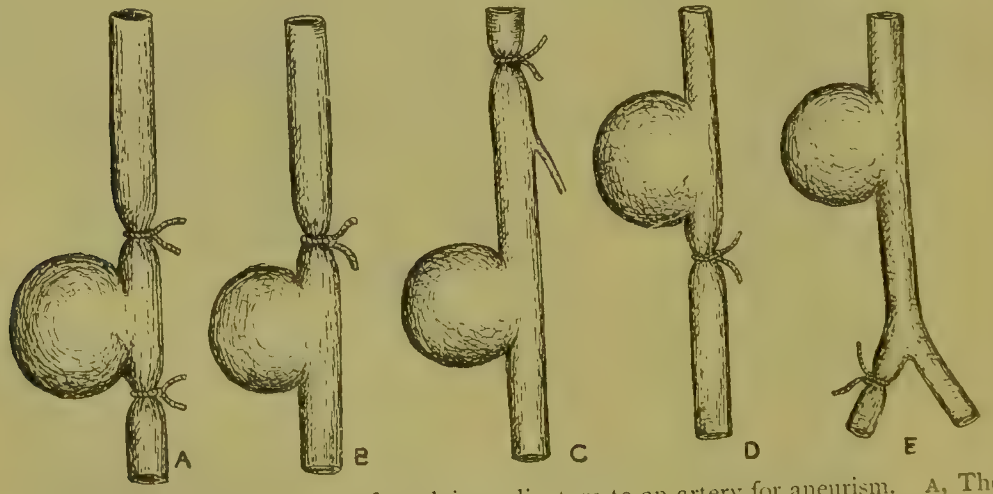

FIG. 100.—The various modes of applying a ligature to an artery for aneurism. A, The method of Antyllus. B, Anel's operation. C, Hunter's operation. D, Brasdor's operation. E, Wardrop's operation.

but it cannot be undertaken without considerable risk to the patient, as gangrene of the limb and rupture of the sac have both occurred from its use. It is, moreover, by no means certain in its results, and should never be employed where there is disease of the heart or an internal aneurism, on account of the increase in the blood pressure in the heart and large arteries in consequence of the displacement of the blood from the limb.

2. **Treatment by ligature** (fig. 100). The treatment of aneurism by ligature was practised by the older surgeons. The first method of treatment, usually called the old operation or the method of Antyllus, consisted in laying open the sac, turning out the clot, and ligaturing the artery above and below the aneurism. This was followed by the method of Anel, which consisted in ligaturing the artery immediately above the aneurism, without opening the sac.

Seventy-five years afterwards Hunter introduced his operation, which is known as the Hunterian operation, and consists in ligaturing the artery at a distance from the aneurism. These three operations all aim at ligaturing the artery on the cardiac side of the aneurism; but in those cases where this cannot be done, Brasdor proposed tying the trunk of the artery on its distal side, and finally Wardrop proposed tying the main branches of the artery on the distal side in those cases where neither Brasdor's operation nor ligature on the cardiac side can be done.

The **Hunterian operation** is the one most frequently adopted, and will therefore be first considered. The advantages claimed for this operation as compared with Anel's are four in number. (1) First, the operation of cutting down and tying a normal artery is very much easier and simpler than exposing a vessel close to an aneurismal sac, where the anatomical relations are liable to be disturbed, and possibly the vessel overlapped by the aneurism. (2) That in tying the artery close to the aneurism there is great risk of injuring the sac, which might lead to its inflammation and suppuration. (3) That the artery at some distance from the aneurism is more likely to be healthy, and therefore can be tied with less risk than can be done in close proximity to the sac. (4) That as in all probability branches will be given off from the artery between the point of ligature and the aneurism, which will anastomose with branches given off above the ligature, the circulation through the aneurism will not be completely arrested, but only lessened, a condition favourable to the formation of clot of a permanent character. There is no question that in these days of antiseptic surgery these advantages are not so great as they were in the pre-antiseptic days. Then the second of the advantages claimed for Hunter's operation was one of grave importance, but with our present mode of dealing with wounds this danger has disappeared. Again, with regard to the third advantage claimed for Hunter's method, that the vessel is more likely to be healthy at a distance from the aneurism, it must be confessed that this is rather imaginary than real, and that there is no anatomical evidence to prove that this is so. Nevertheless, in spite of this, the Hunterian operation is the one usually selected by surgeons in applying ligatures to arteries for the cure of aneurism.

When an artery is tied by the Hunterian method the pulsation in the aneurism ceases, and for a time the circulation in the limb is diminished and it becomes paler and colder. Soon, however, the collateral circulation is established, and a slight pulsation may be felt in the aneurism; for, as a rule, branches come off from the artery between the point of ligature and the sac, which, anastomosing with branches coming off above the point of ligature, allow a certain amount of blood to find its way through the sac. This blood flows slowly and feebly through the aneurism and coagulates, the clot extending into the artery and obliterating it as far as the first collateral branch above and below the sac. In this way the aneurism is cured.

The process of coagulation may take place in one of two ways. Either the whole of the blood in the sac may clot at once, and then there is no return of pulsation in the sac; or it may partially clot, forming successive layers on the interior of the sac, and gradually filling it up, giving the appearance of lamination which is so often seen in a cured aneurism. As the artery which communicates with the aneurism becomes blocked, a second chain of anastomosis takes place between the branches coming off from the artery between the ligature and the aneurism and those coming off below the aneurism. Thus the limb below is nourished through a double set of anastomosing vessels. The accompanying diagrammatic sketch is intended to show the various changes which take place in the circulation and vessels after the Hunterian operation (fig. 101).

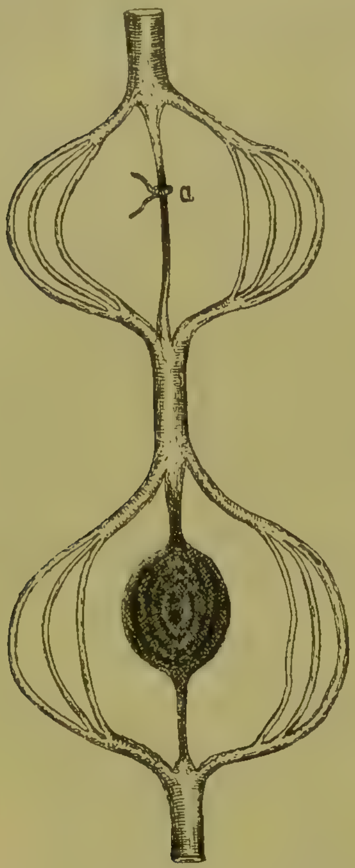

FIG. 101.—Diagram to show the changes in the circulation after ligature of an artery for the cure of aneurism by the Hunterian operation. *a*, Ligature.

Where no branches are given off between the point of ligature and the aneurism, the sac of the aneurism and the vessel between the aneurism and the ligature become filled with blood by a regurgitation from the vessels below the aneurism, communicating with vessels coming off above the ligature; this coagulates, and cure takes place in the same way as before, the whole vessel between the sac and the ligature becoming obliterated.

Dangers of ligature.—The dangers of ligature are: (α) secondary hæmorrhage, (β) gangrene, (γ) inflammation and suppuration around the sac.

(α) *Secondary hæmorrhage* is now almost a thing of the past, but in the old days of the septic ligature it constituted one of the most formidable dangers after ligature of an artery in its continuity (see page 301).

(β) *Gangrene* after ligature is more common in the lower extremity than in the upper. It is usually of the moist kind, and is due mainly to venous obstruction from thrombosis of the accompanying vein, caused by its having either sustained some injury at the time of the operation, or from pressure on the vein, combined with the loss of the vis a tergo. Gangrene of the dry form may also ensue from failure to establish the collateral circulation through a double set of anastomosing arteries.

(γ) *Inflammation and suppuration* around the sac is not so common a danger after the Hunterian operation as when the artery has been ligatured close to the aneurism. It occurs principally in those cases where the aneurism lies in loose connective tissue, as in axillary aneurism, and may arise from the spread of inflammation from the wound, from too much handling of the sac prior to the operation, or from the sudden filling of the sac with soft coagulum.

Treatment after ligature.—The limb should be swathed in a thick layer of cotton wool, retained in position by a flannel bandage. It should be raised on pillows, and if the vessel tied is in the lower extremity, the limb should be laid on its outer side with the knee and hip slightly flexed. Hot-water bottles may be placed in the bed, but should not be brought in contact with the limb. The patient must be kept in bed till complete consolidation of the aneurism has taken place.

If gangrene threatens, the measures recommended on page 142 must be resorted to, and if, in spite of this, moist gangrene is set up, amputation above the aneurism should at once be performed. If dry gangrene occurs it is proper to wait till a line of demarcation is set up. In cases of secondary hæmorrhage the plan of treatment advocated on page 303 must be adopted. In cases of suppuration involving the sac, free incisions should at once be made into it and the clots turned out. In some cases the artery may be tied above and below and the sac excised; but if the inflammation is widely spread, or the sac of the aneurism large and deeply placed, amputation must be performed.

Failure to cure the aneurism by the Hunterian operation is of occasional occurrence, and is one of the main objections to the operation. It may arise from several causes: (1) from too free collateral circulation and want of formation of clot in the vessel as well as the sac of the aneurism. This may arise from the collateral vessels being enlarged by previous attempts to cure the aneurism by pressure, either digital or instrumental (see page 327). (2) Failure may arise from the ligature not proving efficient in closing the vessel. This may be due to too rapid absorption of the ligature, to giving way of the knot, or from the first knot slipping before the second is tied, so that the vessel is not entirely occluded. Recurrence of pulsation in an aneurism after ligature does not indicate that failure has taken place, and the surgeon when this occurs must simply wait, and it will be found in many cases that it will cease in a few days. Where it does not, but rather increases in amount, it is an indication that the operation has failed. Under these circumstances the main artery should be compressed, and the limb gently bandaged from the foot upwards. This in many cases effects a cure. Should it not do so, the better plan would appear to be to ligature the artery immediately above the sac (Anel's operation), or tie it above and below and excise the sac.

The **old operation,** as practised by Antyllus and other older surgeons, was an operation of great difficulty and danger, and was rarely performed on account of the fatal results which usually ensued from either secondary hæmorrhage, diffuse inflammation and suppuration, or gangrene. The operation consisted in first controlling the circulation through the limb, and then in exposing and opening the sac and turning out the clots. The vessel above was then exposed, by dissecting away the part of the sac which overlapped it, and tied. The same process was repeated below, and thus the vessel was secured on either side, and the large wound left, with the sac, to granulate up. Until quite recent times this operation has been rarely performed, except in cases of traumatic aneurism, for which it is particularly adapted; though Syme recommended it in cases of axillary aneurism, and it would appear also to be the best means of treatment in cases of gluteal aneurism, where the Hunterian operation is scarcely applicable. Nowadays there is a growing tendency on the part of surgeons to revive this old operation, with the important addition that the sac is excised. Now that the dangers from hæmorrhage and sepsis can be avoided, the operation holds out much greater prospects of a successful issue, and, if successful, must result in a cure of the aneurism. But at the same time it possesses two serious disadvantages: one is, that there is great danger of wounding important structures in the neighbourhood; the other, that when the aneurism is deeply seated it is very difficult of execution. The operation may be performed after the method of Antyllus, by laying open the sac, turning out the clots and searching for the artery from within; or, what would appear to be a better plan, when practicable, to expose the sac of the aneurism, isolate it by careful dissection from the structures around, then ligaturing the arteries communicating with the aneurism, dividing them between the ligature and the sac, and lifting the aneurism out without opening it.

Anel's operation is seldom done except in those cases where the Hunterian operation is not applicable. It differs from the operation of ligaturing the artery some distance above the sac in the fact that it leaves no current through the aneurism, except the slight and weak reflux from the artery below. The advantages of the Hunterian operation over this have already been considered.

The **distal ligature.**—There are two ways of employing the distal ligature, which differ somewhat in their mode of action. **Brasdor's operation** consists in tying the artery on the distal side of the aneurism and between it and the first large branch (see fig. 103). It is almost entirely confined to the treatment of aneurisms of the lower part of the common carotid artery, where we have a long vessel without any branches, and therefore room for a ligature to be applied between the aneurism and the bifurcation of the artery. It resembles in its mode of action the spontaneous cure effected by the dislodgment of a clot from an aneurism and its impaction in the artery below. After ligature the clot formed on the cardiac side of the ligature may extend along the vessel into the sac, and this, together with the lessened tension in the aneurism caused by the diversion of the blood current, may succeed in curing the aneurism. The operation is, however, rarely successful. Though it may succeed in checking the progress of the aneurism for a time, it will in most cases eventually be found that the improvement was only temporary, and the sac will begin to increase again.

Wardrop's operation is based on a rather different principle. It aims at diminishing without entirely arresting the current of blood through the aneurismal sac, by tying some but not all the branches coming off from the diseased vessel (see fig. 102). For example, in an aneurism of the innominate artery, the common carotid and the third portion of the subclavian may be tied, still leaving a current of blood flowing through the sac of the aneurism to reach the branches given off from the first and second parts of the subclavian artery. It holds out a better chance of success than Brasdor's operation, but on the whole the results are not very satisfactory, for in cases of innominate aneurism, where the carotid and third part of the subclavian arteries have been tied simultaneously, in many instances the flow of blood through the branches of the subclavian has been so great as to prevent the cure of the aneurism. In some cases, therefore, the vertebral artery has also been ligatured.

To sum up, then, it should be laid down as a rule that the distal ligature should never be resorted to when the proximal ligature can be applied.

Temporary ligature.—One other plan of applying a ligature to an artery for the cure of aneurism requires a passing notice. It has been proposed to apply some temporary compressing force to an artery, which shall impede the flow of blood through the vessel without occluding it. This may be done in several ways: by passing an acupressure needle under the vessel and a figure-of-8 ligature over it and under the needle; or by exposing the vessel, passing a silver wire under it, and bringing the ends out through the skin some distance from the wound and twisting them over a piece of cork, with sufficient tension to impede without completely obstructing the current of the blood. Special instruments, e.g. Dix's wire compressor and Spiers' artery constrictor, have been devised for the same purpose. The plan of treatment appears, however, to possess no advantage over the permanent ligature, and to possess the distinct disadvantage that a clot may form in the vessel above the constricting force, and that when this is released the clot may be carried onwards and impacted in some vessel in the course of the circulation.

We have now to consider very briefly the various other plans which have been recommended at different times for the cure of aneurism.

3. **Excision.**—Complete extirpation of an aneurismal sac is theoretically the best and most satisfactory method of dealing with an aneurism, and it is a plan of treatment which has been recently revived by some surgeons. It is not, however, always practicable, and under most circumstances is an operation which is beset with difficulties. The ideal plan is to remove the tumour without opening it; first securing the artery by ligature above and below, and also any branches which may open into the sac; but this is not always possible on account of the adhesions to other structures which may exist. The operation seems especially applicable to the treatment of small aneurisms of the third part of the subclavian artery. The results of some cases in which this operation has been recently performed have been very satisfactory.

4. **Manipulation.**—This plan of treatment was introduced by Sir William Fergusson, and aims at displacing a portion of clot from the sac of the aneurism into the mouth of the sac or the vessel below. As we have already seen, spontaneous cure of an aneurism is sometimes brought about by this means, and the object of this operation is to imitate nature in this respect. The proceeding is carried out by first compressing the artery above, and stopping the circulation of blood through the aneurism; the sac is then inverted with the thumb until the upper surface of the wall of the sac is in contact with the lower, then by a rotatory movement of the thumb the walls are rubbed together. By this means a portion of clot may be detached, and is then carried along in the circulation; if of sufficient size it blocks the mouth of the aneurism or the vessel immediately below. Some cases of cure by this means have been recorded, but the proceeding is of considerable risk from embolism, from rupture of the sac, or from inflammation from the violence that has been used. It was employed by Sir W. Fergusson in two cases of aneurism of the subclavian, but neither case afforded satisfactory evidence of its efficacy or safety, and manipulation is now no longer resorted to.

5. **Injection of coagulants.**—At various times efforts have been made to cure aneurism by injecting substances, such as perchloride of iron, fibrin-ferment, and tannin, into the sac, so as to cause coagulation of its contents.

The operation is, however, attended with great risk of embolism, or of subsequent inflammation and suppuration of the sac, and cannot therefore be safely recommended except in very rare cases. If resorted to, compression of the artery both above and below the aneurism must be employed, not only during the operation, but for some time afterwards.

6. **Galvano-puncture** is another means which has been employed for bringing about coagulation in an aneurismal sac. The operation is performed as follows : several steel needles, insulated to within half an inch of their points, are introduced parallel to one another at the distance of about an inch in such a manner that the points are free in the sac and not touching the wall. One of these needles is connected with the negative pole of a Leclanché's battery of from ten to fifteen cells—a continuous current battery of high tension, but low intensity—the other needles are connected with the positive pole. The current is continued until the tumour becomes sensibly firmer and harder. The operation will probably require repeating two, three, or more times before a cure is effected. Coagulation takes place around the positive needles, and is attended by the evolution of gas, which is sometimes so considerable as to cause the aneurism to give a resonant note on percussion. This phenomenon need not, however, embarrass the surgeon ; it apparently does no harm. When a decided effect is produced, the current is reversed for a moment to prevent leakage from the punctures, the needles withdrawn, and the little wounds sealed with collodion. This plan of treatment has been attended with more success than any of the other methods under consideration, and should certainly be tried in those cases in which treatment by ligature or compression cannot be undertaken. It does not appear to be frequently followed by embolism, but suppuration of the sac has resulted in some of the cases.

7. **Injection of ergotin** into the neighbourhood of the sac of the aneurism was recommended by Langenbeck, with the view of exciting contraction of the muscular fibres in the wall of the sac, and thus gradually causing a diminution in its size. There is no satisfactory evidence that it has ever been of any use.

8. **Acupuncture** has been employed in the treatment of aneurism in some cases with success. Fine needles are introduced into the sac, and left there for four or five days with the view of inducing coagulation around them, acting as foreign bodies in the sac. A somewhat modified form of this has been recently introduced by Macewen of Glasgow, who inserts his needles in such a way that the points shall be in contact with the inner wall of the sac opposite the site of introduction. From the constant contraction and dilatation of the aneurism the inner surface becomes scratched by the site of the needle, and this is said to favour the formation of a clot. The needles are left in for twenty-four or thirty-six hours, and the position of the points is constantly shifted. Macewen has recorded some very satisfactory results. In the only case in which I have tried this plan of treatment, I found the greatest difficulty when inserting the needles in ascertaining when the opposite side of the sac was reached. The results as regards improvement were practically nil.

9. **Introduction of foreign bodies.**—Based on the same principle as the introduction of needles, fine steel wire, catgut, and horsehair have been passed into the sac of an aneurism. It is, however, intended to remain in permanently. Very little success has attended this plan of treatment, but then it has never been resorted to except in desperate cases. The greatest

difficulty has been experienced in introducing the wire in a perfectly aseptic condition, and the late Mr. Hulke invented a small apparatus by which the wire can be paid off from a drum, inclosed in a vessel containing a solution of carbolic acid, directly into the sac. This plan of treatment should only be adopted in those cases where the more approved methods are impracticable. Quite recently a case of successful treatment of an aneurism of the abdominal aorta by this method has been recorded by Mr. Langton.

SPECIAL ANEURISMS

Aneurism of the thoracic aorta.—Aneurism of the arch of the aorta falls rather under the care of the physician than the surgeon, and can very rarely be made the subject of surgical treatment. Aneurisms are more frequently met with in this vessel than in any other, and especially in the ascending portion of the arch. The signs by which they may be recognised vary much, and they may often exist for a very considerable time without giving rise to any symptoms by which they can be recognised. They usually make themselves known by their pressure effects, as the tumour is so deeply placed that there may be no external swelling, and a bruit is very often absent. The pressure effects vary with the position and size of the tumour. There may be intense pain between the blade bones from pressure on the spine; cyanosis, and distension of the veins, and œdema from pressure on the great systemic veins; dyspnœa from pressure on the trachea or bronchi; dysphagia from pressure on the œsophagus; paralysis of the abductor of the vocal cord from pressure on the left recurrent laryngeal nerve, or if the pressure is greater of both abductor and adductor, with loss of voice. In addition to this there may be an increased area of dullness on percussion; displacement of the apex beat of the heart on the wall of the chest, and inequality of the pulses at the two wrists, which may be verified by a sphygmographic tracing. Later on a swelling may appear. If the arch is the part affected this may show itself just to the right of the middle line, either displacing or absorbing and perforating the thoracic wall, or it may appear in the neck in the supra-sternal notch. In aneurism of the descending aorta, the tumour shows itself, if it presents at all, in the back to the left of the spine. In this swelling there is pulsation, and sometimes, but not always, a bruit, which may accompany either the systole or the diastole.

The **treatment** of thoracic aneurism must be left to the physician, and under the influence of rest, conjoined with those other constitutional means mentioned on page 320, most cases will improve, and life may be considerably prolonged. It is only when the aneurism is bulging externally that surgical treatment is indicated, and then the probable issue is not satisfactory. Galvano-puncture, acupuncture, the introduction of foreign bodies into the sac, and distal ligature, are the four measures which can be adopted in the treatment of these cases; and of these, probably the first two hold out the best hope of doing good, since by them a clot may be formed which may become organised, and strengthen the sac, and retard its further increase. In cases where a sacculated aneurism has formed, they may succeed in obliterating it altogether.

Aneurism of the innominate is very difficult to diagnose from aortic aneurism, and indeed is very often associated with it. In the early stages, before the tumour projects, it may be suspected by its pressure effects, dyspnœa, stridor, cyanosis, and œdema of the right upper extremity and right side of the head, neck, and face, with venous engorgement, and a more feeble pulse on the right side than the left. In addition to this there may be dullness over the manubrium sterni and inner end of the clavicle. Later on a pulsating swelling may appear between the two heads of origin of the sterno-mastoid, pushing the upper part of the sternum and sternal end of the clavicle forwards.

The **treatment** of innominate aneurism is the same as that of aortic, absolute rest and constitutional treatment, since operative interference holds out little prospect of success. Should, however, the tumour increase in spite of treatment, then it is justifiable to resort to the simultaneous ligature of the common carotid and the third portion of the subclavian artery, according to Wardrop's operation (fig. 102). Cases have been recorded where, after the performance of this operation, the tumour has consolidated and ceased to grow for a time.

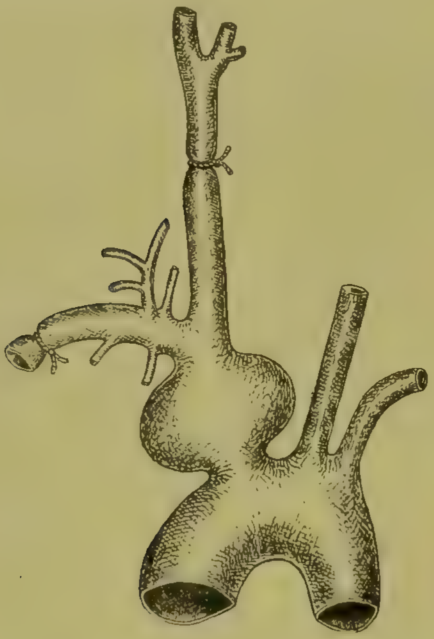

FIG. 102.—Diagram to show ligature of the subclavian and carotid vessels for the cure of innominate aneurism by Wardrop's method.

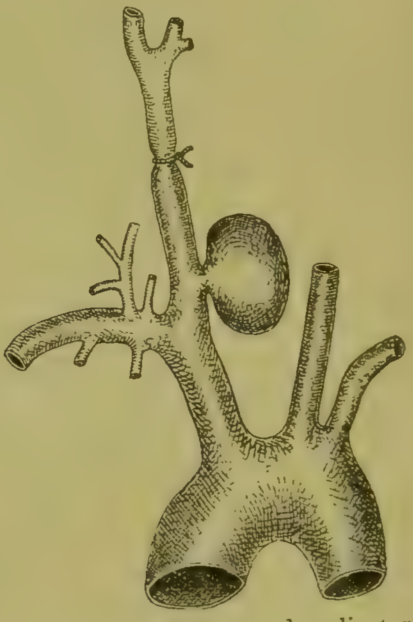

FIG. 103.—Diagram to show ligature of the carotid artery for the cure of carotid aneurism by Brasdor's method.

Aneurism of the carotid artery is most frequently found just below the point of bifurcation. It may also affect the right carotid close to its origin from the innominate, but appears rarely if ever to affect the intra-thoracic portion of the left carotid. The diagnosis is usually easy, except where it affects the right carotid low down, when it is liable to be mistaken for aortic or innominate aneurism, but the tumour tends rather to present beneath the sternal head of origin of the sterno-mastoid rather than internal to it as in aortic aneurism, or external to it as in innominate aneurism. It is liable, however, to be mistaken for other tumours; cysts under the sterno-mastoid, enlarged thyroid, fatty tumours, lymphatic glandular tumours, and chronic abscess have all been mistaken for aneurism. A carotid aneurism at the root of the neck usually extends upwards by the side of the trachea, and may give rise to dyspnœa, and by pressure on the sympathetic and recurrent laryngeal nerves cause a contracted pupil on the affected side, and hoarseness and loss of voice. Through interference with the circulation in the brain, it may cause giddiness or stupor. The pulse in the temporal artery on the affected side is weaker and smaller than on the opposite side, while the two radial pulses are the same.

The **treatment** of carotid aneurism must depend upon its situation. If the aneurism is at the root of the neck, low down in the carotid, distal ligature by Brasdor's method (fig. 103) is the plan of operative treatment which is indicated, but this should not be adopted until a fair trial has been made of constitutional treatment, since, as we have already pointed out, the distal ligature does not hold out very strong prospects of cure. Nevertheless, if there are any cases in which Brasdor's operation is likely to do good, it is in aneurism in this situation. If, on the other hand, the aneurism is in the situation where carotid aneurisms are most usually found, near the bifurcation of the artery, then digital compression should always first be resorted to, if practicable, before any attempt to ligature the artery on the cardiac side is undertaken. This is on account of the risk which attends ligature of the common carotid artery from deficient supply of blood to the brain, producing softening. The artery may be compressed by the finger against the anterior tubercle of the transverse process of the sixth cervical vertebra, which lies about two inches above the clavicle. Should this fail, then the Hunterian operation of ligature of the common carotid must be undertaken.

Ligature of the common carotid (fig. 104).—The common carotid artery may be tied in any part of its course, but the 'seat of election' is at the level of the cricoid cartilage, where the operation can be performed with greater facility than in any other position. This is just about the level at which the omo-hyoid muscle crosses the vessel, and it is generally more convenient to apply the ligature just above the tendon of this muscle. The surgeon, standing on the side of the patient on which the operation is to be performed, draws the chin a little upwards and turns the head to the opposite side, so as to define the anterior border of the sterno-mastoid muscle. He then makes an incision, three inches long, with its centre opposite the cricoid cartilage, in the course of the artery—from a point midway between the angle of the jaw and the mastoid process to the right sterno-clavicular joint—and divides the skin, superficial fascia, platysma, and deep fascia. This will expose the anterior border of the sterno-mastoid and the anterior belly of the omo-hyoid, passing upwards and inwards. The operator draws the sterno-mastoid outwards with a blunt hook, and, if necessary, the omo-hyoid downwards. The sheath of the vessels will now be exposed, with the descendens hypoglossi generally lying upon it, and the pulsation in the artery will be felt. Sometimes a little troublesome hæmorrhage is experienced from the thyroid veins in clearing the sheath. The sheath is to be opened well to the inner side, so as to avoid the internal jugular vein, which frequently overlaps the artery, when distended. In opening the sheath the small sterno-mastoid branch of the superior thyroid may be cut, and under these circumstances must be at once tied or twisted, as otherwise the blood from it would find its way into the sheath and interfere with the subsequent nutrition of the vessel. The descendens hypoglossi must be carefully avoided; it generally lies to the outer side of the artery, but its position is very variable. The sheath having been opened on the inner side by pinching up a small portion with forceps and cutting it off with the knife held horizontally, the edge of the small circular hole thus formed is to be grasped with forceps while a director is introduced gently between the artery and the sheath, and by a to-and-fro movement the one is to be separated from the other, first on one side of the vessel and then on the other. Still holding the margin of the opening in the sheath in the forceps, the aneurism needle is now to be passed from without inwards, and having been threaded with the ligature is to be withdrawn. The artery is thus encircled by the ligature, but before it is tied the vessel should be raised slightly by tensing the loop in order to see whether the pulsation in the artery beyond the ligature is commanded, and to satisfy the surgeon that he has not included any other structure. The ligature is now tied, the ends cut off close, and the wound sutured and dressed.

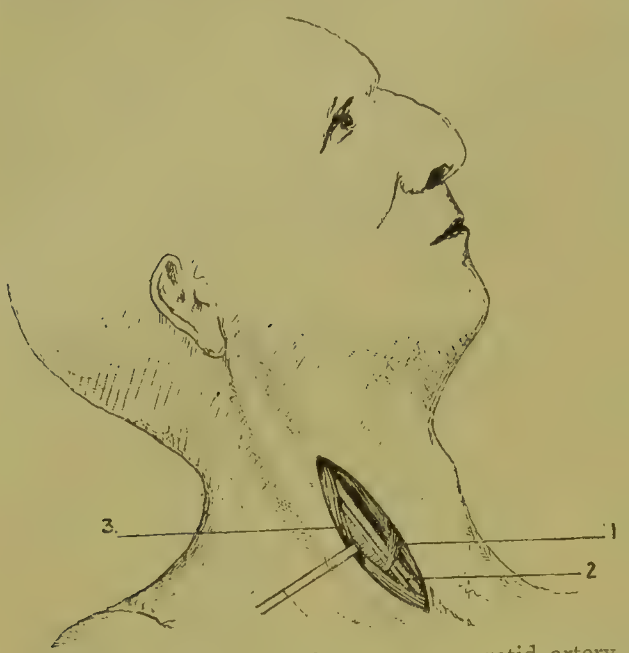

Fig. 104.—Ligature of the common carotid artery. 1, Omo-hyoid muscle; 2, Descendens hypoglossi nerve; 3, Anterior border of sterno-mastoid muscle.

The operation of tying the common carotid in the lower part of the neck is more difficult because the artery is more deeply seated. An incision is made in the line of the artery from the level of the cricoid cartilage almost to the sterno-clavicular joint, and the anterior edge of the sterno-mastoid exposed. This is to be drawn outwards, when the sterno-hyoid and probably the sterno-thyroid will come into view; these two muscles are to be drawn inwards, and if necessary partially divided on a director. Division of the sternal head of the sterno-mastoid may also be necessary if it cannot be retracted sufficiently; in dividing it great care must be taken to avoid wounding the anterior jugular vein, which crosses the sheath of the vessels as it passes outwards under the sterno-mastoid. When these muscles are sufficiently retracted, the sheath will be exposed and the artery may be felt pulsating. It must be opened well to the inner side, especially when the operation is performed on the left side of the neck, as the vein here is in close proximity to the artery and generally partially overlaps it. On the right side there is an interval between the two vessels. When the sheath is opened and the artery cleaned, the aneurism needle must be passed from without inwards, care being taken not to include the recurrent laryngeal nerve which lies just behind the artery.

Ligature of the common carotid is attended by a considerable mortality. The tables of Pilz give a mortality of about 43 per cent., and though this is probably considerably higher than the mortality of the present day, still a considerable number of cases succumb from impaired nutrition of the brain. Erichsen says that he has come to the conclusion that one-fourth of all the cases of ligature of one carotid are followed by cerebral disturbance, and that one half of these are fatal. The interference with the cerebral circulation may kill in one of two ways; either by inducing softening, which gives rise to convulsions, hemiplegia, and death, or by setting up a low form of pneumonia owing to the disturbed circulation in the medulla.

Ligature of the internal carotid is not often performed. It may be required for wounds of the vessel, and possibly in some cases of aneurism it may be substituted for ligature of the common carotid. The artery can only be tied at its commencement by an incision along the anterior border of the sterno-mastoid, the centre of which is to be a little above the upper border of the thyroid cartilage.

Ligature of the external carotid (fig. 105) is an operation which should always be done for wounds of its branches, which cannot otherwise be secured, in preference to ligature of the common carotid, on account of the fact that by it the circulation in the brain is not in any way interfered with. The main objection that has been raised against it is the fear of secondary hæmorrhage from the close proximity of large branches to the ligature, but this has been proved by statistics to be more theoretical than real. There is usually about half an inch of the artery available for the purpose between the origin of the superior thyroid and the lingual arteries; and if these two vessels are ligatured at the same time as the main vessel is secured, there need be no fear of secondary hæmorrhage taking place.

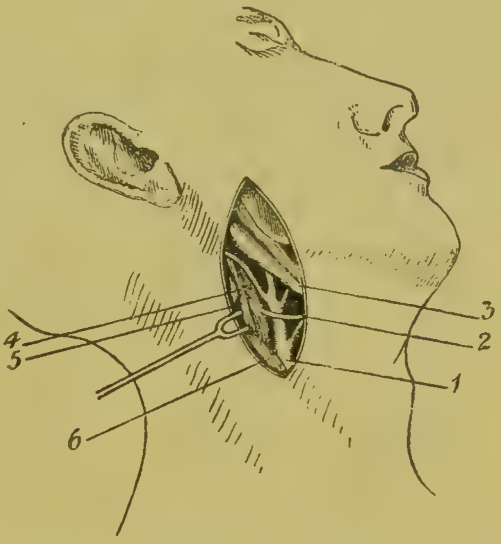

FIG. 105.—Ligature of external carotid artery. 1, External carotid; 2, Hypoglossal nerve; 3, Digastric muscle; 4, Internal carotid artery; 5, Internal jugular vein; 6, Sterno-mastoid muscle.

The head having been placed in the same position as for ligature of the common carotid, an incision is made about a quarter of an inch in front of the anterior border of the sterno-mastoid from the level of the angle of the lower jaw to that of the upper border of the thyroid cartilage, and the skin, platysma, and deep fascia divided. Upon opening up the cellular tissue beneath the deep fascia, in which are some lymphatic glands and veins, the posterior belly of the digastric and a little lower the hypoglossal nerve will be exposed. This nerve forms the guide to the artery, which will be felt pulsating immediately beneath it. The vessel is to be carefully cleared in this situation, taking care to preserve the descendens hypoglossi which lies on the sheath. Especial care must be exercised towards the outer side of the vessel, for here the internal carotid artery and internal jugular vein are in close proximity. After the sheath is opened and the vessel separated from it, the needle is to be passed from without inwards, bearing in mind that the superior laryngeal nerve runs obliquely downwards and inwards behind the artery.

Another operation for tying the external carotid artery above the digastric muscle is sometimes practised, but it cannot be recommended, as it endangers some of the branches of the facial nerve.

The branches of the external carotid artery sometimes require ligaturing, but the only one which necessitates a separate description is ligature of the lingual branch. Ligature of the thyroid arteries will be alluded to in connection with operations for removal of the thyroid body.

Ligature of the lingual artery has been performed in order to attempt to arrest the growth of cancerous tumours of the tongue by starving them, and also before and sometimes after removal of the tongue to control the hæmorrhage. The patient's head being turned to the opposite side and the chin raised, a semicircular incision is made from a little external to the symphysis of the lower jaw in a curved direction to the apex of the great cornu of the hyoid bone, and then upwards and backwards nearly to the angle of the lower jaw. It should not be carried quite as high as the angle, so as not to wound the facial artery, but should stop just in front of the line of this vessel. The skin, superficial fascia, platysma, and deep fascia are divided. The submaxillary gland will now be exposed, and is to be hooked upwards with a retractor. A small triangle, bounded by the posterior belly of the digastric above, the hypoglossal nerve below, and the posterior border of the mylo-hyoid muscle in front, is now seen. The floor of the triangle is formed by the hyoglossus muscle, beneath which is the artery. A director is to be carefully inserted beneath the muscle and its fibres divided, or they may be scratched through with the point of the knife, care being taken to avoid wounding the lingual vein, which generally lies on the muscle. Upon dividing the muscle the lingual artery will be found running parallel to the upper border of the hyoid bone. In passing the aneurism needle care must be taken not to perforate the fibres of the middle constrictor of the pharynx, on which the artery lies and by which and the mucous membrane it is separated from the pharyngeal cavity.

Orbital aneurism.—Under the term *orbital aneurism* are included several different conditions which give rise to a pulsating swelling in the orbit. These cases are classed together on account of their presenting very similar clinical characters, though the pathological changes which have given rise to them are very diverse. Among the conditions which have been found after death in cases of orbital aneurism are the following: Aneurism of the ophthalmic artery *within* the orbit, in one case only;[1] aneurism of the ophthalmic artery within the cranium and outside the orbit; aneurysmal varix, formed by a communication of the internal carotid artery with the cavernous sinus; rupture of the internal carotid artery into the sinus; thrombosis of the cavernous sinus; compression or obliteration of the ophthalmic veins by old inflammatory products. In addition to these, cases of pulsating tumour of the orbit have occurred in which after death no arterial disease was found. Rivington, who has written a most exhaustive paper on the subject,[2] believes that in cases of congenital origin the symptoms may be produced by cirsoid aneurism of the arteries of the orbit, though this condition has never been demonstrated by post-mortem examination.

The **causes** of this condition are in many cases obscure. In those collected by Rivington more than one half were attributable to injury, either fracture of the base of the skull or penetrating wounds of the orbit; the rest were idiopathic. Many of the cases where the disease occurred spontaneously commenced quite suddenly with a sharp crack or noise in the head, accompanied by severe pain, leading to the inference that a small aneurism of the carotid had given way into the sinus. And in the traumatic cases it seems probable that an arterio-venous aneurism is the most frequent pathological lesion which would produce the symptoms. Further than this, the differential diagnosis of the various pathological conditions giving rise to a pulsating tumour in the orbit is scarcely possible.

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[1] Guthrie's case, in which an aneurism was found on the ophthalmic artery on both sides. *Operative Surgery of the Eye*, 1823, p. 158.

[2] *Med. Chir. Trans.* vol. lviii. p. 183.

The **symptoms**, after the preliminary pain and noise, when these occur, are protrusion of the eyeball, with swelling and congestion of the lids and conjunctiva; pulsation of the eyeball; a pulsating tumour, generally situated above the eye beneath the inner part of the orbital arch; more or less impairment of sight, with paralysis of the iris and the orbital muscles; pain of varying intensity, and a loud whizzing bruit. The essential symptoms are, according to Rivington, the exophthalmos, the bruit, and the congestion of the conjunctiva.

Treatment.—The symptoms have been known to subside spontaneously, and therefore it is better at first to watch the case, and if no great inconvenience is experienced it may not be necessary to adopt any treatment. When, however, on account of the inconvenience or persistence of the symptoms, treatment becomes necessary, constitutional remedies, combined with such digital compression of the common carotid as the patient can tolerate, should be first tried, and failing this ligature of the common carotid should be performed. This has been followed by very satisfactory results.

Aneurism of the subclavian artery.—An aneurism may form on any part of the subclavian artery, except the intra-thoracic portion of the left vessel, which is said never to be the seat of aneurism. The most common situation is the third part of the artery, external to the scalenus anticus muscle, and on the right side of the body. This greater frequency of occurrence on the right side of the body is no doubt due to the greater amount of use to which the right upper extremity is put. The disease is especially common in sailors, who are engaged in hauling heavy ropes &c., and therefore subjecting their arms, and especially the right arm, to great strain.

Symptoms.—An aneurism of the subclavian artery is generally characterised by a small tumour in the subclavian triangle. It varies in size, and may sometimes attain an enormous bulk (fig. 106), and as it increases it bulges forwards the sterno-mastoid muscle. It presents the ordinary symptoms of aneurism as regards bruit, pulsation, &c., and the radial pulse is weaker and delayed on the affected side. The pressure effects depend on the part of the vessel affected. When it is confined to the third part of the artery the brachial plexus or its branches may be pressed upon, producing pain and numbness in the arm and fingers, with loss of power or paralysis in the muscles of these parts. Œdema may also be present from pressure on the subclavian vein. The external jugular vein may also become involved and become distended and varicose. When the first part of the artery is involved, pressure on the internal jugular and vertebral veins may cause œdema of the head and face, with lividity, congestion of the brain, and a semi-conscious state. The phrenic nerve may be involved, causing spasmodic action of the diaphragm, or the recurrent laryngeal, producing paralysis of the vocal cord on the affected side. An aneurism of the first part of the artery may also press on the trachea and œsophagus, producing dyspnœa and dysphagia.

Subclavian aneurism has a tendency to become diffused, when it loses its defined character, increases rapidly, and may burst externally or into the pleural cavity or trachea.

Treatment.—The treatment of subclavian aneurism is very unsatisfactory. The ordinary measures for treating these aneurisms by proximal compression or ligature are scarcely available in these cases, since ligature of the first part of the subclavian is never successful and ligature of the innominate only very rarely so, and there are few cases where proximal pressure can be applied; so that unless the aneurism is situated so low down on the artery that it partakes more of the character of a subclavio-axillary aneurism, so that a ligature can be placed on the second part of the vessel, which is rarely the case, the treatment by proximal ligature has to be abandoned. The other means of treating aneurism, by manipulation, galvano-puncture, &c., have been tried, and though cases here and there have been recorded where it has been successful, there are many more in which it has failed. The best mode of proceeding in the treatment of subclavian aneurism would appear to be, in the first instance, to give a steady and careful trial to constitutional treatment by rest, attention to diet, and medicine, and by combining with this direct pressure over the aneurism by means of a bag of shot.

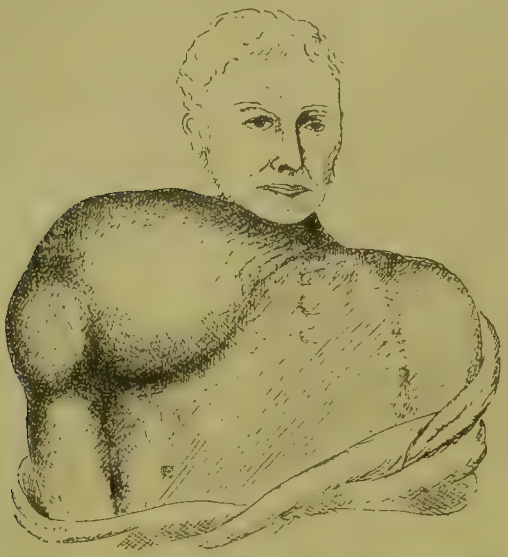

FIG. 106.—A subclavian aneurism of large size. (From a drawing of a patient in St. George's Hospital.)

If this fails, a ligature should be placed on the proximal side of the aneurism, if there is sufficient room to ligature the second part of the vessel; or in cases of right subclavian aneurism of larger size it may be proper to apply a ligature to the innominate artery.

It would appear that in many cases of aneurism of the third part of the subclavian artery, where the treatment by constitutional means, aided by direct pressure, has failed, the best plan of treatment consists in excising the sac by the modern plan (page 335). This, of course, must be done while the aneurism is still small and before it has become diffused. In those cases where the aneurism is of large size, or has become diffused, the only alternative is amputation at the shoulder joint, after preliminary ligature of the axillary artery below the aneurism.

Ligature of the innominate artery.—This formidable operation, which until recent times had only succeeded once, must now, with the practice of aseptic surgery and our greater knowledge of the use of the ligature, be regarded as a legitimate means of treating right subclavian aneurism.

The operation has been done in twenty-four cases, and in five of these with a successful result; out of these five, four have been performed in recent times. According to Mr. Jacobson these five cases are: Smyth's in 1864, Mitchell Banks' in 1883; Lewtas's in 1889; Coppinger's in 1893; and Symonds' in 1894.

The operation should only be done in those cases where the aneurism is so limited that there is reason to believe that the innominate artery is not involved, and any alteration in the shape of the bones or joint over the artery would be a clear indication that this was not so.

Prior to the operation the patient should be brought into as satisfactory a condition as possible by preparatory treatment, and before and during the operation the most rigid antiseptic precautions should be observed and continued until the wound is soundly healed. The patient should be slightly turned to the left and propped up with pillows in this position, with the head turned to the same side and the shoulder depressed as much as possible. An incision is made about three inches in length along the anterior border of the sterno-mastoid muscle, and a second of the same length along the inner third of the clavicle, which meets the first at an angle just internal to the sterno-clavicular joint. The skin, platysma, and fasciæ are divided in these incisions, and the triangular flap dissected up. The clavicular and sternal origins of the sterno-mastoid, the sterno-hyoid, and sterno-thyroid are now successively divided on a director. These muscles should not be divided close to the bone, so as to allow for their more easy suturing afterwards. The carotid sheath is now fairly exposed, after division of a layer of cervical fascia which runs down behind the depressors of the hyoid bone. The surgeon must follow the carotid artery downwards to its origin, keeping his director as close to the anterior surface of the vessel as possible. As soon as the finger is in the thorax, beyond the bifurcation of the innominate, the cleaning of the vessel must be undertaken with the greatest caution, especially on the outer side where are the innominate vein and the pneumogastric nerve, as well as the pleura. By gentle teasing, the vessel may be cleared and the aneurism needle passed from below and to the outer side, upwards and inwards. This manœuvre may be facilitated by drawing up the carotid, having first tied it and left the ligature long. It is well to be provided with an aneurism needle made of flexible metal, so that its curve can be altered to any degree required. In cases where the bifurcation is very low, so that the needle cannot be inserted around the artery, it may be necessary to remove the inner end of the clavicle and, it may be, a portion of the sternum. The needle having been inserted, it is threaded and withdrawn and the knot tied. This must be done so as not to lacerate any of the arterial wall, but sufficiently tightly to stop the pulsation in the sac of the aneurism. Probably the best form of ligature to use is a kangaroo tendon, but silk and catgut have been used successfully. After the ligature has been tied and cut short, the carotid should be ligatured if this has not already been done. The severed muscles are now to be united with buried sutures; a drainage tube inserted, and the wound closed and dressed. Morphia is generally necessary after the operation, as absolute quietness is imperatively called for, and the arm should be lightly bandaged to the side. The drainage tube should be removed within the first forty-eight hours.

Ligature of the first portion of the subclavian artery.—It seems scarcely necessary to say much about ligature of the first portion of the subclavian artery, which has uniformly proved fatal, and which in all probability will never prove a successful operation, on account of the facility with which blood is poured into the distal end of the artery through the collateral vessels, thus rendering secondary hæmorrhage a very probable contingency. It will be sufficient to say that the operation should only be done on the right side, for on the left it is situated at such a depth as to be scarcely practicable, though it has once been done by Rodgers of New York. On the right side it may be best tied by a very similar operation to that for ligature of the innominate until the common carotid is found. Then by tearing through the cellular tissue to the outer border of the sterno-thyroid the triangular space between the carotid artery and internal jugular vein will be exposed, in which will be seen the subclavian crossed by the pneumogastric nerve; the ligature is to be placed just external to this point, the needle being passed from below upwards.

Aneurism of the axillary artery is a more common affection than subclavian aneurism on account of the injury to which the artery may be exposed in the free movement of the arm at the shoulder joint. It occurs more frequently on the right side; in men than in women; and may arise from any part of the artery. On account of the loose connective tissue in which it is contained, aneurism of this artery is liable to grow very rapidly and attain a large size, and from the same cause is apt to become diffused, and sometimes to inflame and suppurate. As a rule it does not project downwards into the armpit on account of the strong axillary fascia, but projects above the upper border of the pectoralis minor, either pushing outwards the costo-coracoid membrane and clavicular origin of the pectoralis major or passing under the clavicle and projecting in the subclavian triangle. The pressure effects are œdema and blueness of the arm, and when the obstruction is very great symptoms of impending gangrene; pressure on the brachial plexus causes intense pain in the arm, and in some cases pressure on the thoracic wall causes absorption of the upper ribs, and the aneurism projects into the thorax, pressing on and displacing the lung.

The **treatment** of axillary aneurism is the treatment of any external aneurism, viz. proximal digital pressure, and failing this proximal ligature. When the aneurism is idiopathic, small, and well circumscribed, digital compression should be first tried if possible; the possibility depending upon the height to which the artery rises in the neck, the level of the clavicle, and the thickness of the neck. In some cases the digital compression of the subclavian artery against the first rib is a matter of the greatest simplicity; in other cases the difficulties of doing it are insurmountable. Where difficulty is experienced in digital compression, or where the patient is unable or unwilling to bear it, the third portion of the subclavian artery should be tied, or if the aneurism has encroached on the subclavian artery—subclavio-axillary aneurism—the second portion of the vessel may be ligatured. When the aneurism is of great size and projects into the subclavian triangle, the treatment must be the same as for subclavian aneurism. In those cases where the aneurism has become diffused, or where it is traumatic in its origin, it must be cut down upon, laid open, the clots turned out, and the vessel secured above and below. Before doing this it is advisable to make an incision above the clavicle, as for ligature of the subclavian artery, and divide the deep fascia, in order that efficient pressure may be made on this vessel so as entirely to control the circulation.

Ligature of the third portion of the subclavian artery (fig. 107).—The patient is to be laid on his back, with his shoulders slightly raised, so that the head can be thrown well back. The face is turned towards the opposite side, and the shoulder is drawn down by an assistant as much as possible. The surgeon now draws down the skin of the neck over the chest with his left hand, and makes an incision three inches in length over the middle third of the clavicle. The skin is then released, and the incision will now lie above the bone. The object of this manœuvre is to avoid wounding the external jugular vein ; as this vein perforates the deep fascia, it cannot be drawn down with the skin and superficial tissue, and therefore escapes injury. The deep fascia is to be incised on a director to the extent of the skin wound. In doing this great care must be exercised not to wound the external jugular vein, and if the deep fascia cannot be freely incised without endangering the vein, it is better to at once divide it between two ligatures. The loose cellular tissue of the subclavian triangle, in which is a plexus of veins, is to be scratched through with a director till the margin of the scalenus anticus is exposed. In case any large veins are in the way they should be drawn aside or divided between two ligatures, as it much facilitates the further steps of the operation to keep the parts as free of blood as possible. Occasionally the supra-scapular or transversalis colli arteries may be exposed, and should be scrupulously preserved and on no account ligatured and divided, as they are of importance in establishing the collateral circulation after ligature of the subclavian. After the outer edge of the scalenus anticus has been exposed, it is traced down to its insertion into the first rib, and the artery will be found immediately above and behind the scalene tubercle, into which the muscle is inserted. Above and behind the artery is the cord of the brachial plexus, formed by the eighth cervical and first dorsal nerves, which often forms an important guide to the vessel, but which at the same time must not be mistaken for it, an accident not unlikely to occur, since the cord often receives a pulsation from the artery. But if the operator adopts the precaution recommended in speaking of igature of the common carotid, of compressing the vessel between his orefinger and the ligature before tying it, he can satisfy himself by the absence of pulsation in the vessels below that the artery is included in he ligature, and at the same time he may make certain that nothing but he artery has been included. In passing the needle the surgeon must depart from the usual rule in ligaturing arteries, of inserting it between the

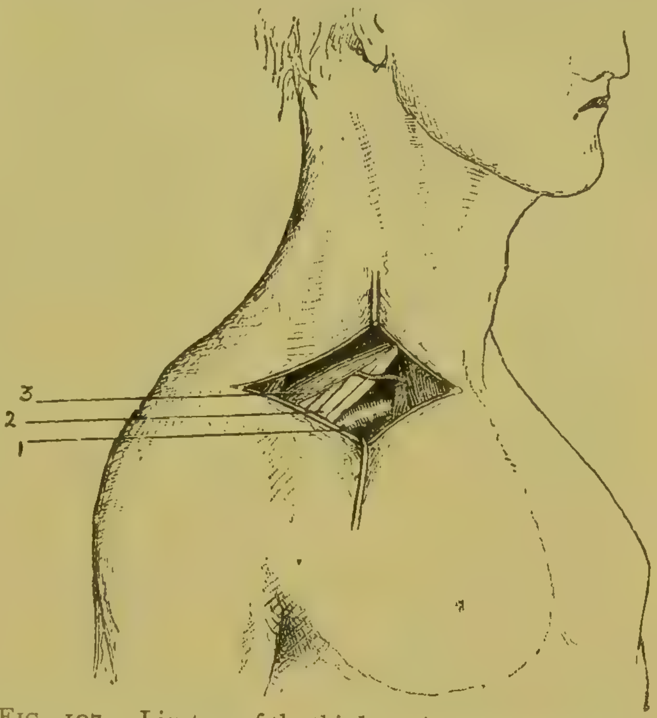

FIG. 107.—Ligature of the third portion of the subclavian artery. 1, Subclavian artery ; 2, Brachial plexus ; 3, Omo-hyoid muscle.

artery and vein and passing it away from this latter vessel. In the third portion of its course the subclavian vein is so far below the clavicle that there is no chance of wounding it, while there is a real risk of including the lowest cord of the brachial plexus in the ligature if the needle is passed from below upwards. It should always, therefore, be passed around the vessel from above; that is, between the lowest cord of the brachial plexus and the vessel.

Ligature of the third portion of the subclavian artery for axillary or subclavio-axillary aneurism has not hitherto proved a very satisfactory operation; about half the cases having terminated fatally. The chief causes of death are the close propinquity of the pleura, which may be injured in the operation or in which inflammation may be set up after the operation: inflammation and suppuration in the sac, due to the close proximity of the ligature to the sac, without any intervening branch; and secondary hæmorrhage.

Ligature of the second portion of the subclavian artery.—In cases where the aneurism encroaches so far on the subclavian artery that it is impossible to apply a ligature to the third part, the operation may be extended and the second part tied. This is essentially the same operation as ligature of the third portion, except that a little more room is required. This may be obtained by carrying an incision upwards from the inner extremity of the first incision and dividing some of the fibres of the clavicular head of the sterno-mastoid. This will expose the scalenus anticus, and under this muscle a director must be inserted with great care, so as to avoid injuring the pleura which lies immediately below, and the outer two-thirds of the fibres of the muscle may be divided. The greatest caution must be observed to avoid wounding the phrenic nerve, which, however, at this part of its course usually lies close to the inner border of the muscle, so that if the division is confined to the outer two-thirds, the nerve will escape damage. On the left side the thoracic duct is also in danger. Where ligature of the second portion of the artery is performed on the right side, it is a wise precaution to also ligature the superior intercostal artery, which on this side comes off from this portion of the vessel.

Ligature of the vertebral artery.—The vertebral artery has sometimes been ligatured at the same time as the innominate, or subsequently to ligature of this vessel, in order to arrest hæmorrhage, when it has occurred at the seat of ligature from reflux of blood through the subclavian. It also sometimes requires ligature for traumatic aneurism or wound. Dr. Alexander of Liverpool some years ago recommended its ligature in cases of epilepsy in order to diminish the supply of blood to the hinder part of the encephalon and upper part of the cord, with a hope that by this means the epileptic fits would be lessened or got rid of altogether. The results, however, did not appear to be sufficiently satisfactory to induce Dr. Alexander to persevere with the operation, after he had given it a fair trial in a considerable number of cases.

The operation is performed by making an incision, about three inches in length, along the posterior border of the sterno-mastoid, down to the clavicle, and a second incision along the clavicle with its centre joining the first. Care must be taken in making the first incision not to wound the external jugular vein. After the superficial structures have been divided, the deep fascia is incised in the same lines, and the posterior fibres of the clavicular origin of the sterno-mastoid divided on a director. This muscle is then to be drawn inwards, and by careful working with the point of a steel director in the deep connective tissue, the interspace between the scalenus anticus and the longus colli is to be defined. In doing this important structures have to be avoided, the phrenic nerve lying on the scalenus anticus, the internal jugular, vertebral and inferior thyroid veins, and the pleura internally : in addition to these, on the left side the thoracic duct is endangered, as it crosses the artery from within outwards to terminate in the left subclavian vein. The interspace between the two muscles having been defined, the anterior tubercle on the transverse process of the sixth cervical vertebra is to be sought for, and the artery will be felt pulsating immediately below this. The vessel must be cleared in this situation and the needle passed from without inwards. Contraction of the pupil on the side operated upon very frequently follows the tightening of the ligature from interference with the sympathetic, and by some surgeons is looked for as an indication that the artery has been tied.

Idiopathic aneurisms of the arteries below the axilla are exceedingly rare, and when they do occur are almost always the result of cardiac disease and embolism ; on the other hand, the traumatic form of the disease is of frequent occurrence, especially occurring in the radial artery just above the wrist, where the vessel is superficial and exposed to injury from punctured wounds.

The arteries of the upper extremity, however, frequently require ligature for wounds, either at the point wounded or in some instances, as in wounds of the palmar arch, above the injured spot.

Ligature of the axillary artery is scarcely ever required as a formal operation, as the only cases in which ligature is called for are those of wound of the vessel, and in these cases it is better and simpler to adopt the plan, originally recommended by Guthrie, of dividing the great pectoral muscle across and freely exposing the axilla. This is to be done by making an incision from the centre of the clavicle to the middle of the anterior fold of the axilla, and cutting through the superficial structures and the great pectoral muscle. The artery may then be tied either above or below the pectoralis minor, and if necessary this muscle may also be divided and the artery tied beneath it. Afterwards the divided muscular fibres are united by buried sutures, and the arm kept fixed to the side until union has taken place. In the rare instances in which ligature of the first part of the axillary artery is called for, in cases other than wounds, the operation may be done by a curved incision, with its convexity downwards, from the tip of the coracoid process to about an inch internal to the sterno-clavicular joint, dividing the clavicular origin of the pectoralis major. But in these cases, on account of the depth of the artery, it is far preferable to tie the third part of the subclavian artery.

Ligature of the third part of the axillary artery may be required for aneurism of the brachial high up. It has also been tied for subclavian aneurism both with a view of curing the aneurism by a distal ligature and also as a preliminary to amputation of the shoulder joint. The operation is performed by raising the arm and rotating it slightly outwards ; the artery can then be generally felt pulsating, and an incision about three inches long should be made over it. Otherwise the incision should be made in the line of the artery at the junction of the anterior third with the posterior two-thirds of the space between the anterior and posterior folds of the axilla. The skin and superficial fascia are to be divided in this incision : and when the deep fascia is exposed, it is to be opened carefully, and divided on a director, so as to avoid the axillary vein, which lies immediately beneath and will now be exposed. The vein, which here overlaps the artery, is to be gently drawn inwards and the artery exposed, surrounded by the cords of the brachial plexus. The nerves are to be held aside and the needle passed from within outwards, care being taken not to go closer than is necessary to one of the large branches, subscapular or circumflex, which come off from this part of the vessel.

Ligature of the brachial artery (fig. 108) may be required for spontaneous or traumatic aneurism; for wounds of the palmar arch; for wounds of the vessel itself, and in some other rare cases. When done as a formal operation the centre of the artery, where it rests on the insertion of the coraco-brachialis, is generally selected as the site for the ligature. The arm is raised to a right angle with the body, and is held in this position by an assistant, with the forearm flexed. An incision is then made along the inner border of the biceps, or, if this muscle cannot be defined, in the middle of the arm in a line drawn from the junction of the anterior and middle thirds of the axilla to midway between the two condyles of the humerus. The skin, superficial and deep fasciæ, are divided and the inner

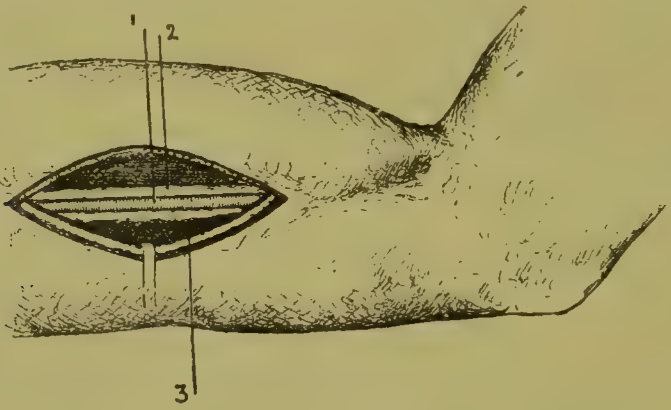

FIG. 108.—Ligature of the brachial artery.
1, brachial artery; 2, venæ comites; 3, median nerve.

border of the biceps exposed; the median nerve will now come into view where it crosses in front of the artery, and should be drawn on one side and the pulsation of the artery felt for. If the median nerve crosses behind the artery, the pulsation will be felt immediately on retracting the edge of the biceps. The artery having been defined, the sheath must be opened and the needle passed from the nerve, care being taken not to include either of the venæ comites. In the earlier stage of the operation the basilic vein must be avoided.

Ligature of the ulnar artery.—The ulnar artery may be ligatured in the upper part of the forearm, but this is very rarely necessary. The course of the artery is indicated by a line drawn from the middle of the bend of the elbow to the outer side of the pisiform bone; but in applying a ligature to the vessel, at the junction of its upper and middle thirds—the most convenient situation—the incision should be made in the line of the anterior border of the flexor carpi ulnaris muscle—from the tip of the internal condyle to the pisiform bone. The incision should be about three inches in length, and its centre should be a hand's breadth below the level of the elbow. The skin and superficial fascia having been divided and the deep fascia exposed, a white line which marks the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis digitorum should be sought for, and when found the deep fascia should be incised along this line. The connective tissue between these two muscles should be separated with the finger or a director, and the flexor carpi ulnaris drawn inwards with a retractor. The ulnar nerve, which at this point lies superficially and a little to the inner side of the artery, will first be seen, and immediately below and external to this the artery will be found. The venæ comites must be carefully separated from it, and the aneurism needle passed from within outwards.

Ligature of the ulnar artery in the lower third of the forearm is more frequently required. The vessel here lies between the flexor carpi ulnaris and the innermost tendon of the flexor sublimis digitorum, with the ulnar nerve to its inner side. An incision a couple of inches in length is made along the outer border of the flexor carpi ulnaris, and the superficial structures and the deep fascia, which is here thin, are divided. The wrist is now to be slightly flexed, so as to permit of the tendon of the flexor carpi ulnaris being drawn inwards, the veins separated from the artery, and the needle passed between the nerve and the artery from within outwards.

Ligature of the radial artery.—The radial artery may also be tied in the upper part of its course or at the wrist.

In the upper part of its course the artery is slightly overlapped by the supinator longus, which will have to be retracted outwards in order to expose the vessel. An incision two or three inches in length is made in a line drawn from the centre of the bend of the elbow to the inner side of the styloid process of the radius. The deep fascia is exposed and incised along the anterior border of the belly of the supinator longus. The muscle is then drawn outwards, and the artery at once comes into view. The radial nerve lies some distance from the artery, and is not seen in this operation.

Just above the wrist the radial artery may be ligatured by making an incision midway between the tendons of the supinator longus and the flexor carpi radialis, with the forearm in a position of supination. Care must be taken to avoid the radial vein or a large tributary of it, which lies superficial to the artery. The deep fascia, which is thin, must be then divided on a director, and the artery will be exposed, with the companion vein on either side. These must be separated, and the aneurism needle may be passed in either direction. In the ligature of either ulnar or radial artery near the wrist care should be observed not to open up the tendon sheaths.

Abdominal aneurisms are not common. They may affect either the abdominal aorta or one of its branches, or the common iliac artery. When the main vessel is the seat of the disease the aneurism most frequently arises from near the origin of the cœliac axis or else at the bifurcation. Of the branches, the superior mesenteric, the inferior mesenteric, or the splenic are the ones most frequently affected. The aneurism, especially when originating from the main trunk, is generally saccular, but may be fusiform.

These aneurisms generally terminate by rupture either into the peritoneal cavity or into some part of the alimentary canal, but they may kill by exhaustion from pain and interference with the functions of the abdominal organs. The symptom which usually draws attention to the disease is pain, and when the aneurism presses on the bodies of the vertebra, causing erosion, the pain, which is of a burning, boring character, is extremely severe. A tumour which pulsates may then be detected in or near the middle line. In this an aneurismal bruit may be heard. The pressure signs are pain from pressure on the lumbar plexus or its branches, especially the genito-crural nerve; obstruction from pressure on the bowel; albuminuria, jaundice, and vomiting. The inferior vena cava is not generally pressed upon sufficiently to produce œdema of the lower extremities. The disease may be mistaken for a 'pulsating aorta,' a not uncommon condition in anæmic women. But the absence of any tumour, the fact that the pulsation can be stopped by the pressure of a single finger, and that it can be traced along the line of the artery, is sufficient to establish a diagnosis; and this may be confirmed by watching the case and noting that no alteration in the condition takes place. A solid mass of fæces in the transverse colon, receiving an impulse from the aorta, may be mistaken for an aneurism; but the doughy nature of the swelling and the want of a distensile pulsation, with its superficial position, will readily determine the nature of the case.

A sarcomatous tumour growing from the bodies of the vertebræ is the disease which presents the greatest similarity to aneurism, and sometimes the diagnosis between the two is almost impossible. The amount of expansion of the tumour, the want of constancy in the pulsation, and the character of the bruit, together with the consistence of the swelling, are the principal points which the surgeon must look to in forming an opinion.

After a diagnosis of aneurism has been made, it is often extremely difficult to determine whether it is the main trunk or one of its branches which is affected. The diagnosis of aneurism of one of the branches is arrived at mainly by the position of the aneurism and by its greater mobility; this is especially noticeable in aneurisms of the superior mesenteric artery, which can sometimes be displaced considerably to one or the other side. Aneurisms of the common iliac are known by their position, and by the fact that pressure symptoms affect only one side of the body.

Treatment.—There can be no question that in the treatment of abdominal aneurism a most careful and protracted course of treatment by constitutional means should first be tried. Any other plan of treatment holds out such a small chance of success, that it is not right to subject the patient to it until a fair and adequate trial of these measures has been adopted. By rest, by dieting combined with medicine, a certain percentage of cases have been very materially benefited. Should this fail, compression of the aorta above the aneurism should be tried, as holding out the best hope of effecting a cure. Lister's aortic tourniquet may be applied to the abdominal aorta throughout the greater part of its course. Durham applied it 'between the cartilages of the ribs,' and Hulke midway between the ensiform cartilage and the umbilicus. There are special risks in this proceeding—risks of contusing the viscera or the great sympathetic ganglia, or of embarrassing the action of the heart. The patient should be kept during the compression under the influence of an anæsthetic, not only on account of the pain induced, but in order to relax the abdominal muscles. This, of course, adds to the risk, as the protracted anæsthesia is in itself a source of danger. Previous to applying the tourniquet, the alimentary canal should be emptied as far as possible and the urine drawn off. Several cases of abdominal aneurism have been cured in this way. Another plan of treatment which has been adopted in some cases is pressure on the distal side of the aneurism, and though possibly further evidence is required before absolutely abandoning this plan, the experience hitherto gained does not hold out much hope of its proving of any use.

Inguinal aneurisms are aneurisms which are situated in the groin, and which most frequently implicate both the external iliac and the common femoral artery, consisting of an hour-glass-shaped sac, with a constriction at Poupart's ligament. The aneurism often presents slight symptoms at first, forming a small pulsating tumour in the groin, which causes little inconvenience. It may attain considerable size, forming a large sac in the iliac fossa without causing much swelling externally, where the artery is supported by the strong fascia lata. After a time it begins to produce serious pressure symptoms, œdema of the leg from pressure on the femoral vein, and pain down the leg and in the scrotum from pressure on the anterior crural and genito-crural nerves. Inguinal aneurisms frequently become much solidified, and this makes the diagnosis very often difficult, as the pulsation in them may become very feeble or cease altogether. They may be mistaken for abscess, enlarged glands, and sarcoma in the groin. The diagnosis must be made on general principles, but in many cases is surrounded with difficulty, especially as regards the diagnosis between a pulsating sarcoma and a partially solidified aneurism.

The **treatment** of inguinal aneurism must vary according to the nature of the case. In all instances a trial should first be given to rest and constitutional treatment; and as inguinal aneurisms show a great tendency to consolidation, this plan of treatment would appear to hold out more prospect of success in this situation than in almost any other. Combined with the constitutional means, direct pressure on the sac may be resorted to. Failing this, the next resource is ligature. If the aneurism does not extend far up the external iliac artery, this vessel may be ligatured, otherwise it will be necessary to tie the common iliac. But in some cases the aneurism extends too high to permit of ligature of even the common iliac. The surgeon has then three alternatives: (1) to apply instrumental compression to the abdominal aorta just above its bifurcation; (2) to tie the abdominal aorta; and (3) to resort to galvano-puncture or some other means of inducing coagulation in the sac. If the patient is not very fat, and the aneurism does not encroach upon the bifurcation of the aorta, the first of these three measures should be tried. The probabilities of a successful issue are not, however, very great. Failing this, as the abdominal aorta has been tied at least seven or eight times without success, it would seem that the patient has a better prospect from galvano-puncture or acupuncture. Distal ligature has been tried in these cases, but has failed to effect a cure.

Ligature of the external iliac (fig. 109).—There are several ways in which the external iliac artery may be tied. Abernethy, who was the first to tie this vessel, in his original operation, made an incision from the centre of Poupart's ligament, upwards and inwards, along the course of the vessel; but subsequently modified it and made a more curved incision from the same spot upwards and outwards. Sir Astley Cooper made an incision parallel to and a little above Poupart's ligament. Both these operations were performed without opening the peritoneum. In the present day, when the old dread of interfering with the peritoneal cavity is a thing of the past, surgeons have evinced a tendency to tie the common iliac artery or either of its subdivisions by a transperitoneal route for divers reasons: (1) the operation is easier and occupies less time; (2) the danger of the operation is not increased by opening the peritoneal cavity; (3) any portion of the vessels can be ligatured according to the exigencies of the case; and (4) accidents which have happened in adopting the older measures are avoided.

The modified method of Abernethy.—The patient should be prepared for two or three days before the operation, by being kept in bed, on a regulated diet, with aperients, so that the intestinal canal shall be as empty as possible. An incision should now be made from an inch above and internal to the anterior superior spinous process of the ilium in a curved direction, with its convexity outwards and downwards, to a point one inch and a half above the middle of Poupart's ligament. The superficial structures having been divided, the external oblique muscle is exposed, and should be incised to a similar extent as the external wound by cutting between the fibres instead of across them, so as to minimise as much as possible the risks of ventral hernia. The internal oblique and transversalis are then carefully divided, and the transversalis fascia is exposed. This fascia is to be seized in a pair of forceps close to the inner extremity of the wound, where there is more subperitoneal tissue and less risk of wounding the peritoneum, and a slight opening made in it by cutting with the knife held horizontally. A broad hernia director is then introduced through the opening, and the peritoneum pushed away from the fascia as it is passed onwards in the line of the external incision. If care is not taken in doing this, the peritoneum is liable to overlap the end of the director and to be wounded in incising the fascia. When the transversalis fascia has been thoroughly divided throughout the whole extent of the wound, the peritoneum must be gently separated from the iliac fossa with the fingers, and with the whole of the tissues on the inner side of the wound held out of the way with a broad curved spatula. The artery is now to be sought for at the brim of the pelvis, and will here be felt pulsating. The tissues around it must be carefully cleared away; a matter sometimes of considerable difficulty, as the glands which surround it are often enlarged and more or less matted together. When the sheath is exposed it must be opened, and the needle passed from within outwards, avoiding

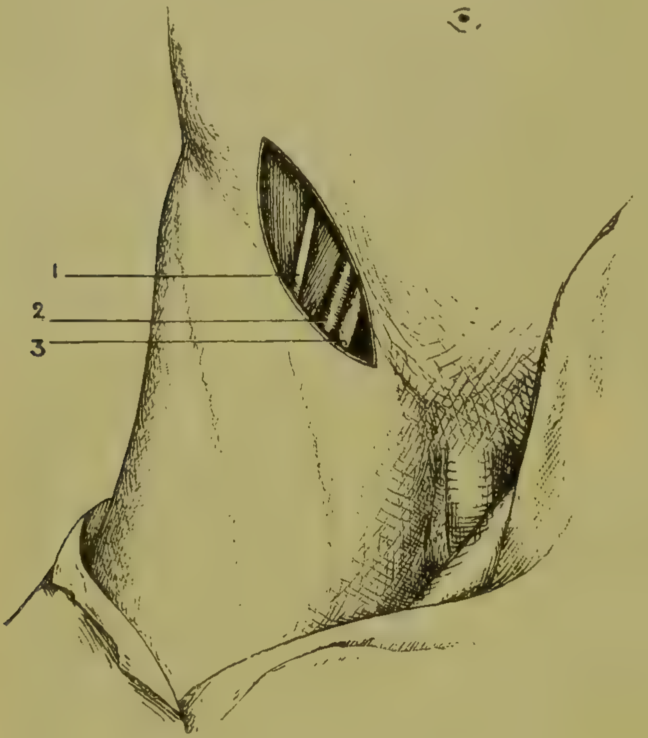

FIG. 109.—Ligature of the external iliac artery by the modified Abernethy's method. 1, anterior crural nerve; 2, external iliac artery; 3, external iliac vein.

the vein to the inner side and the genito-crural nerve, which lies on the sheath.

Sir Astley Cooper's method.—In this operation the incision is made in a curved direction from a little above and outside the external abdominal ring, and carried downwards and outwards to the level of Poupart's ligament, and from this upwards and outwards to about an inch and a half from the inner side of the anterior superior spinous process of the ilium. This incision lays bare the aponeurosis of the external oblique, which is divided. This exposes the inguinal canal with the spermatic cord, surrounded by the cremaster muscle. The cord with the arched fibres of the internal oblique and transversalis muscles are to be drawn upwards with a hook retractor, and the transversalis fascia will be exposed. The fascia is next torn through with a director and forceps, and the artery will be felt pulsating. By clearing away a little loose areolar tissue, the lower part of the artery may be exposed, its sheath opened, and the ligature passed from within outwards about an inch above Poupart's ligament, so as not to place it too close to the origins of the deep epigastric and circumflex iliac arteries. Care must be taken to avoid wounding the deep epigastric artery, which lies on the inner side of the wound between the transversalis fascia and the peritoneum ; or the circumflex iliac vein, which crosses the artery a little above Poupart's ligament. The genital branch of the genito-crural nerve which lies on the artery must also be avoided.

The relative advantages and disadvantages of these two operations would appear to be as follows : Sir Astley Cooper's interferes with the peritoneum less than Abernethy's ; it is easier in its performance, and, it is said, is less liable to be followed by ventral hernia ; it possesses, however, this serious disadvantage, that a ligature can be applied to only the lower part of the artery, whereas by means of Abernethy's operation the vessel can be tied at any part of its course, or, if it should be judged necessary, by prolonging the incision upwards the common iliac artery can be tied.

The transperitoneal operation.—It would seem probable that in the future, when the surgeon has occasion to ligature the external iliac artery he will select the transperitoneal route, for the reasons above enumerated. Certainly this should be done in those cases where it is uncertain whether he will have to tie the external or common iliac ; for though the common iliac may be tied by an extension of Abernethy's operation for the external iliac the operation is one of great difficulty, and is attended by many risks of accident, such as ligaturing the ureter with the artery ; injuring the vas deferens ; wounding the deep epigastric or circumflex iliac artery or vein, and, in addition to this, the risk of cellulitis being set up from the injury necessarily done to the subserous areolar tissue.

The operation is very easily performed by an incision in the semilunar line, which divides all the structures in the abdominal wall and opens the peritoneal cavity. The intestines are then pulled out of the way by a broad spatula, and the peritoneum incised at the margin of the pelvis over the course of the vessel. The sheath of the vessels is opened, the artery cleared, and the aneurism needle passed from within outwards. After the vessel is secured, the peritoneum over the artery should be stitched with fine catgut, so as to make the artery and ligature once more extra-peritoneal.

Ligature of the common iliac artery.—Now that abdominal section may be regarded as almost free from danger, when performed with proper antiseptic precautions, it is probable that the common iliac artery will always be ligatured by the transperitoneal method. It seems, therefore, scarcely necessary to occupy space by describing the older methods, and it will be sufficient to say that it can be done by extending the incision used by Abernethy for ligature of the external iliac artery upwards and inwards towards the umbilicus, or by a posterior incision partly in the abdomen, partly in the loin, by the method introduced by Crampton. This incision is a curved one with its concavity directed towards the umbilicus, extending from the tip of the last rib to the anterior superior spinous process of the ilium, and the peritoneum is raised from the subjacent structures, without being incised.

In the transperitoneal operation the abdomen is opened by an incision in either the semilunar line or the linea alba ; the intestines are drawn on one side, and the peritoneum covering the artery divided. The sheath is then opened and the needle passed from within outwards. On the right side great care must be exercised in passing the needle, since both the common iliac veins lie behind the artery. After the vessel has been tied the incision in the peritoneum over the artery should be sutured, so as to exclude it from the peritoneal cavity.

Ligature of the internal iliac.—The internal iliac artery may be tied by the same incision that is employed for ligature of the common iliac, and the vessel may be found by tracing the common iliac downwards or the external iliac upwards until the bifurcation is reached. The peritoneum over the vessel is then incised and the artery exposed. The ligature should be applied round the vessel about an inch from its origin, and then the ureter, which crosses the common iliac about its bifurcation, will not be endangered. Care must be taken not to mistake the obturator nerve for the artery.

Gluteal Aneurisms.—Aneurisms of the buttock, or, as they are generally called, gluteal aneurisms, may implicate either the gluteal, sciatic, or internal pudic artery. In about one half the cases they are traumatic in their origin, and in some of these there may be no sac, the blood being simply circumscribed by coagulating in the tissues around the artery. In these there may be no pulsation. In the spontaneous form, however, and in the circumscribed traumatic form there is usually a strong pulsation and a loud bruit to be heard on auscultation. The most marked pressure effect is pressure on the sciatic nerve, which occasions severe pain along its course, and sometimes gives rise to paralysis. In the idiopathic form of the disease, the sac may lie partly inside the pelvis, so that in gluteal aneurism an examination should always be made by the rectum in order to ascertain, if possible, whether this is so or not. Gluteal aneurism may be mistaken for abscess, or for sarcoma of the ilium. With regard to the former the diagnosis ought to be fairly easy by attention to the general signs and by the absence of any bruit ; but with regard to sarcoma the diagnosis is sometimes difficult. In doubtful cases, aspiration or hooking out of a small fragment of the growth and examining microscopically should be practised.

Treatment.—In the traumatic form of the disease and in those cases of idiopathic aneurism where the surgeon can assure himself that the sac is entirely outside the pelvis, the best treatment would appear to be the old operation of Antyllus, especially if the aneurism is increasing and threatens to burst, or if the pressure on the nerves is causing great pain.

Cases of spontaneous cure have been recorded, but they are very few. Compression of the abdominal aorta or of the common iliac, or digital compression of the internal iliac from the rectum, have been tried, but without much success. In those cases where the sac of the aneurism is partly within the pelvis, ligature of the internal iliac by the transperitoneal operation is to be recommended, though some cases have been successfully treated by galvano-puncture or coagulating injections.

Ligature of the gluteal artery.—In cases where it is determined to perform the old operation for gluteal aneurism, or its more recent modification—excision of the sac—the first point to consider is the method of controlling the circulation through the vessel during the operation. I have no doubt that the most efficient means of doing this is by Davy's lever introduced into the rectum. In the only case in which I have seen this operation performed,[1] the bleeding was so thoroughly controlled by the lever that the artery was exposed as cleanly and clearly as it would have been in the dead subject. The position of the patient during the operation precludes the use of Lister's abdominal tourniquet.

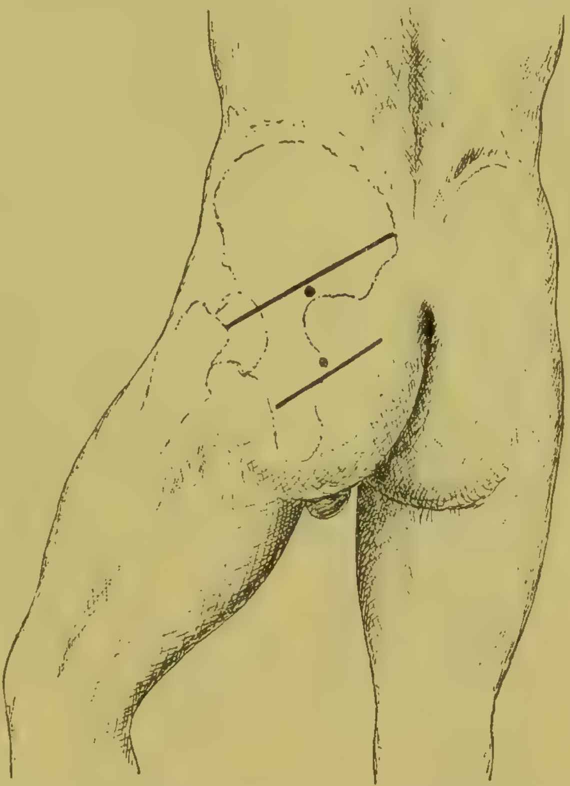

FIG. 110.—Lines of incision for ligature of the gluteal and sciatic arteries. (Modified from MacCormac.)

The patient is turned two-thirds over on to his face, and an incision almost parallel with the fibres of the gluteus maximus should be made in a line drawn from the posterior superior spinous process of the ilium to the junction of the upper and posterior borders of the great trochanter (fig. 110). When the gluteus maximus is exposed, its fibres should be separated through the whole thickness of the muscle and well pulled apart with retractors. The contiguous margins of the gluteus medius and pyriformis are now to be separated from each other, and the artery will be exposed emerging from the sciatic notch. If there is simply a ruptured vessel, without any aneurismal sac, the artery must be isolated and tied on either side of the opening. If, on the other hand, there is a distinct aneurismal sac, the artery should be secured as far within the sciatic notch as possible, and then the sac excised if this is practicable; if not, the sac must first be laid open and then the vessel secured above and below.

Ligature of the sciatic artery.—When the aneurism is believed to arise from the sciatic artery, the incision should be made parallel with that for ligature of the gluteal, but one inch and a half lower down. After the fibres of the gluteus maximus have been separated, the vessel is to be sought for at the lower border of the pyriformis; the great sciatic nerve forming the chief guide to the artery.

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[1] *Clin. Soc. Trans.* vol. xvii. p. 172.

Aneurism of the femoral artery.—An aneurism may affect any part of the femoral artery, but is much more common in that part of the artery which lies in Scarpa's triangle than in the lower part of the vessel, where it is contained in Hunter's canal, and is covered by a strong aponeurosis and supported by surrounding muscles. In the upper part of its course the aneurism may be situated either on the common femoral or the superficial femoral; or the profunda femoris may be the artery involved. The differential diagnosis, where the profunda femoris is the artery implicated, would be established by the fact that there would be no alteration in the pulse in the tibial arteries on the two sides of the body, whereas if the common or superficial femoral were involved, the pulsation in the distal vessels would be weaker and probably delayed on the affected side. Aneurisms of the common femoral artery are usually of the fusiform variety. The **symptoms** of femoral aneurism present nothing peculiar, the signs being merely those of external aneurism as found elsewhere.

Treatment.—The treatment of femoral aneurism may be either by compression or ligature. The compression may be either digital, instrumental, or by Esmarch's bandage. Digital compression is peculiarly adapted to these cases, as the femoral artery can be so easily compressed against the os pubis, as it rides over the bone, but still many cases have been recorded in which it has been tried and failed. Ligature may be applied either to the common or superficial femoral according to the part of the artery involved in the disease: the latter should always be selected when possible. Formerly there was considerable reluctance on the part of surgeons to apply a ligature to the common femoral artery, on account of the fear of secondary hæmorrhage from the proximity of one or more of its branches to the ligature, but in the present day, with an aseptic ligature applied only sufficiently tightly to control the circulation without rupturing the internal or middle coat, this danger is obviated. In some cases where the aneurism is situated high up in the thigh it may be necessary to tie the external iliac artery.

Aneurism of the popliteal artery (fig. 111).—Aneurism of the popliteal artery is by far the most common of all surgical aneurisms. This is no doubt due mainly to the facts that the vessel is unsupported and surrounded merely by loose cellular tissue, and is constantly subjected to strain in the movements of the knee joint. The aneurism may be either fusiform or sacculated and is very often symmetrical, a tumour appearing in both hams simultaneously, or else the one appearing some time after the other.

Symptoms.—Popliteal aneurism usually commences with pain and stiffness about the knee, with inability to completely extend the joint, so that the limb is maintained in a semi-flexed position. These symptoms are liable to be mistaken for rheumatism, especially in those cases where the disease is attended by some effusion into the joint. The symptoms vary somewhat in cases of sacculated aneurism as to whether the sac opens into the front or the back of the vessel. When it is situated on the front of the vessel and lies between it and the bone, it increases slowly, but is apt to cause erosion of the bone, when the disease is attended with intense pain of an aching or gnawing character; or it may burst into the joint. When, on the other hand, it is situated on the posterior surface of the artery, it tends to increase rapidly and is apt to become diffused, and this is likely to be followed by gangrene. It causes, by pressure on the popliteal vein, œdema and blueness of the limb below, and by pressure on the internal popliteal nerve pain in the foot, cramp, and finally paralysis.

Treatment.—A popliteal aneurism may be treated by compression, either digital, instrumental, or by Esmarch's bandage; or by flexion or by ligature. In addition to these plans of treatment, it should be mentioned that popliteal aneurisms may undergo spontaneous cure, especially if the limb is kept at perfect rest by confining the patient to bed and placing him on a suitable diet. If the aneurism is small and not increasing rapidly, trial of one of the forms of compression may be made; but considering the fact that this plan of treatment often fails; that if it does fail, the patient is not in such a favourable condition for ligature, in consequence of the enlargement of the collateral vessels; and that the operation of ligature can now be undertaken with an infinitesimal amount of risk, I am not sure that we should not be consulting the patient's welfare by at once proceeding to ligature the artery in cases of popliteal aneurism which show no indications of a tendency to undergo spontaneous cure. If it is determined to resort to ligature, the question then arises, in what position on the vessel should the ligature be placed. The favourite site is undoubtedly the superficial femoral at the apex of Scarpa's triangle; and though this is the most accessible situation and the one in which the vessel can most easily be ligatured, it is very questionable whether it is the best. It is a long distance from the site of the aneurism, and therefore either a very considerable track of vessel, namely, that between the ligature and the sac, must become obliterated, considerably interfering with the circulation in the limb; or else there will be a considerable track of pervious vessel between the ligature and the sac into which the collateral vessels will be pouring their blood in such quantities that no obliteration will take place in the artery at the point from which the aneurism springs, and the operation will fail to cure the aneurism. That such a result is by no means uncommon in treating popliteal aneurism by ligature of the superficial femoral at the apex of Scarpa's triangle is well known. It has therefore been recommended by some to tie the artery in Hunter's canal, where Hunter himself originally tied it in his first operation for popliteal aneurism; and by others, to tie the upper part of the popliteal artery, just after the vessel has emerged through the opening in the adductor magnus. Neither operation presents any great difficulty in its performance, and with modern methods of ligaturing arteries can scarcely be regarded as dangerous.

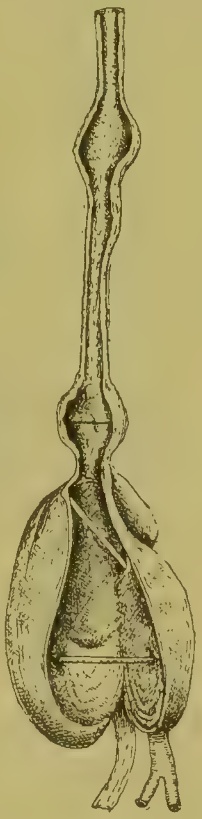

FIG. 111.—Aneurism of the popliteal artery; with two fusiform aneurisms in the vessel above. (From a preparation in the Museum of St. George's Hospital.)

Ligature of the common femoral.—The thigh should be abducted and rotated outwards, and an incision, about two and a half inches in length, made in a somewhat oblique direction over the course of the artery, commencing just above Poupart's ligament. Having divided the skin and superficial fascia, any glands or superficial veins which present themselves are to be drawn aside and the fascia lata divided. The pulsation of the artery will then be felt. The sheath is now to be opened, about an inch below Poupart's ligament; care being taken to avoid the crural branch of the genito-crural nerve, which lies in front of it, and the needle passed round the artery from the inner side.

Ligature of the superficial femoral at the apex of Scarpa's triangle (fig. 112). The limb is to be flexed, abducted, and rotated outwards, and an incision made along the inner border of the sartorius muscle, or if the border of the muscle cannot be defined, in a line from a point midway between the anterior superior spinous process of the ilium and the symphysis pubis to the adductor tubercle on the lower end of the femur. The incision should be about three inches in length, with its centre a hand's breadth below Poupart's ligament. The skin and fasciæ having been divided, the inner border of the sartorius will be exposed, and is to be drawn slightly outwards. The sheath of the vessels will then be seen, with the long muscular branch to the vastus internus lying upon it; occasionally the long saphenous nerve may also be visible. The sheath is now to be opened on its outer side and the artery cleared with the point of a director and the aneurism needle passed from within outwards, great care being observed to keep close to the vessel, so as to avoid contusing the vein, which is very liable to be injured, as it lies behind and to the inner side of the artery.

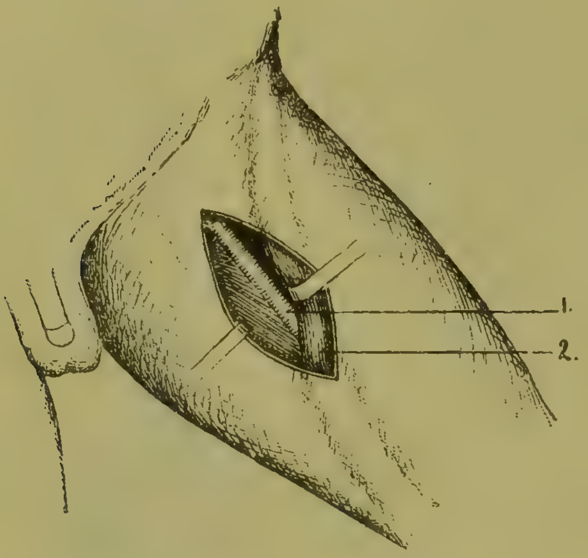

FIG. 112.—Ligature of superficial femoral at the apex of Scarpa's triangle. 1, superficial femoral artery; 2, sartorius muscle.

Ligature of the superficial femoral in Hunter's canal.—The limb having been placed in the same position as in ligature of the artery at the apex of Scarpa's triangle, an incision is made in the course of the artery; that is, in the line from a point midway between the anterior superior spinous process of the ilium and the symphysis pubis to the adductor tubercle. The incision should be three inches in length, and its centre correspond to a point midway between the groin and the knee. The skin and fasciæ are divided and the sartorius exposed; the outer border, which will correspond to the incision in this situation, is to be drawn inwards, and the aponeurotic covering of Hunter's canal will be exposed. This is to be divided on a director, and the artery will then be found. Its sheath is to be opened and the artery cleared, care being taken of the long saphenous nerve which lies in front of the artery and the vein which lies immediately behind. The aneurism needle may be passed in either direction, as is more convenient to the operator.

Ligature of the popliteal artery.—The popliteal artery may be ligatured at its upper part most conveniently by an incision on the inner side of the thigh. The knee is to be flexed and the thigh rotated outwards so that it rests on its outer surface; an incision three inches in length, beginning at the junction of the middle and lower third of the thigh, is to be made parallel to and immediately behind the tendon of the adductor magnus; and the skin, superficial and deep fasciæ divided. The tendon of the muscle is thus exposed, and is to be drawn forwards and the hamstring tendons backwards. A quantity of fatty tissue will now be opened up, in which the artery will be felt pulsating. This is to be separated with the point of a director until the artery is exposed. The vein and nerve will not be seen, as they lie to the outer side of the artery. The sheath is to be opened and the aneurism needle passed from before backwards, keeping its point close to the artery for fear of injuring the vein. The only structure to avoid is the long saphenous vein in the superficial incision. The popliteal artery may also be tied in the upper part of its course by an incision on the back of the limb, along the outer margin of the semi-membranosus, but the operation is a more difficult one, as the internal popliteal nerve and the popliteal vein are first exposed, and great care has to be exercised in separating them from the artery.

Aneurisms of the leg and foot.—Aneurisms below the ham are of very rare occurrence, except when arising from traumatic causes, under which circumstances they are best treated as wounds of the vessel. Ligature of the lower part of the popliteal and the tibial arteries is therefore rarely required for disease, though they require ligature for injury.

Ligature of the lower part of the popliteal artery.—The patient is to be placed in the prone position with the limb extended, and an incision made in the middle line of the ham from the level of the knee joint for about three or four inches. In dividing the superficial structures care must be taken to avoid wounding the external saphenous vein and nerve. After the deep fascia has been divided, the leg should be flexed in order to allow of the separation of the heads of the gastrocnemius. Some loose adipose tissue will now be exposed, in which will be found the internal popliteal nerve, beneath which is the popliteal vein and still lower the popliteal artery. The plantaris muscle may also be exposed lying over the artery. These various structures must be drawn on one side and the artery exposed, care being taken not to wound the sural or other muscular branches of the artery. After the sheath has been opened, the aneurism needle should be passed between the artery and vein.

Ligature of the posterior tibial artery.—The operation of ligaturing the posterior tibial artery in the middle of the leg is one of considerable difficulty. The patient should be placed in the supine position, with the leg flexed at the knee and rotated outwards, so that the limb rests on the table on its outer side. The foot should be extended, so as to relax as far as possible the calf muscles. An incision four inches in length is now made in the middle of the leg, a finger's breadth behind the inner border of the tibia. In doing this care must be taken to avoid wounding the internal saphenous vein and nerve. After the deep fascia has been divided, the inner border of the gastrocnemius will come into view and must be pulled outwards in order to expose the tibial origin of the soleus muscle. When this has been defined a director is to be passed beneath it from below upwards, and the tendon divided about half an inch from its attachment to the tibia. The deep fascia of the leg covering the deep muscles will now be exposed, and the artery will be felt pulsating beneath it about an inch from the tibia. The superficial calf muscles must be retracted as far as possible by a broad retractor, and a strong light thrown into the wound by a reflector. The deep fascia is to be carefully opened over the artery and the veins separated from it. The aneurism needle is to be passed round the vessel from without inwards, so as to avoid injuring the posterior tibial nerve.

The posterior tibial artery may be tied at the ankle joint by making a semilunar incision, with its convexity towards the heel, about three inches long midway between the internal malleolus and the internal tubercle on the under surface of the os calcis. The skin and superficial structures are divided, and the internal annular ligament exposed. This is to be divided on a director, and the artery will be exposed lying between the flexor longus digitorum and the flexor longus hallucis, with the nerve to its outer side. The vessel is to be separated from its venæ comites, and the aneurism needle passed round the vessel from the heel towards the ankle, so as to avoid the posterior tibial nerve.

Ligature of the anterior tibial.—The anterior tibial artery may be tied in the middle of the leg, but the operation is one of considerable difficulty on account of the depth of the vessel. The chief point is to accurately define the outer border of the tibialis anticus muscle, and this should be done before the patient is placed under an anæsthetic, by causing him to put the muscle into action. With the limb turned somewhat to the inner side, an incision four inches in length is made in the line marking the outer border of the fleshy belly of the tibialis anticus, and the deep fascia exposed. The wound must now be carefully dried, its edges retracted, and the white line separating the tibialis anticus from the extensor longus digitorum sought for. When this has been clearly defined, the deep fascia is to be divided in this line and the tibialis anticus separated from the adjacent muscles with the handle of the scalpel or a director until the interosseous membrane is reached. The foot is to be flexed in order to relax the muscles, and upon drawing them apart the artery will be found lying on the interosseous membrane, with the nerve to its outer side or on the top of the artery. The nerve should be drawn outwards and the venæ comites separated from the artery and the aneurism needle passed round it.

Ligature of dorsalis pedis.—The dorsalis pedis artery may be tied by making an incision two inches in length along the outer border of the tendon of the extensor proprius hallucis muscle. The incision should not extend farther forwards than the tarso-metatarsal joint. The skin and fasciæ having been divided the artery will be found, with the nerve lying to its outer side and with the innermost tendon of the extensor brevis digitorum about to cross it.

DISEASES OF VEINS

Thrombosis and Phlebitis.—The principal symptom of inflammation of a vein is a hard cord along the course of the vessel, caused by the coagulation of the blood in its interior. This is called thrombosis, and it was formerly supposed that every case of thrombosis was the direct outcome of inflammation. This, however, is now known not to be so, for though inflammation of the coats of a vein, when it affects the intima, always causes thrombosis, nevertheless thrombosis may occur quite independently of any inflammation, and therefore, though the two conditions are intimately associated, they must still be regarded as two distinct diseases and must be considered separately.

Thrombosis may be defined as the coagulation of the blood in the vessels during life. It may occur in the arteries or in the veins; but inasmuch as it is more common in the veins and leads to more important results, it is usually considered with diseases of these structures. In the arteries it occurs most frequently as a reparative process after injury, as we have already seen.

Causes of venous thrombosis.—The causes of thrombosis are numerous, and may be classified under three different heads: (1) Alterations in the physiological integrity of the wall of the vessel; (2) Alterations in the physiological integrity of the blood; (3) Partial or complete arrest of the blood stream.

1. **Integrity of the wall of the vessel.**—We have already pointed out (page 9) that when the wall of a blood-vessel is in a state of physiological integrity, there is no tendency on the part of the leucocytes to adhere to it: but that when the intima is damaged by disease or injury, then they tend to adhere, and, losing their vitality, disintegrate, and, setting free the fibrin ferment which they contain, cause the blood in the vessel to coagulate. Any alteration or change in the wall of a vein, especially any change which is attended by a diminution in its vitality, excites coagulation, such as injury, inflammation, or degeneration of the coats.

2. **Integrity of the blood.**—The changes in the constitution of the blood which lead to thrombosis are not very well understood. It has been proved experimentally that the introduction of 'fibrin ferment' into the blood in considerable quantities will cause wide-spread coagulation, and it is believed that thrombosis may be due to the setting free of fibrin ferment by the disintegration of the leucocytes. In certain diseases, as pyæmia and septicæmia, in which it is known that disintegration of the leucocytes goes on to a considerable extent, thrombosis is of common occurrence, and it is thought that this may be due to coagulation induced by the free fibrin ferment circulating in the blood stream. Again, an alteration in the constitution of the blood is believed by some to be caused by an excess of excrementitious matter from defective elimination, as in gout. There is no doubt that gout is a frequent cause of thrombosis, and it may be due to this alteration in the blood, but would appear to be due rather to an alteration in the walls of the vessel from a gouty phlebitis.

3. **Partial or complete arrest of the circulation** may cause thrombosis. This retardation may arise from several different causes: a weak heart, either the result of old age or exhaustion after fever or loss of blood, pressure of a tumour &c. on the vein, diminished vis a tergo after ligature of an artery, or division of a vein in surgical operations or injuries.

Varieties of thrombi.—A thrombus varies in appearance according to the rapidity with which it is formed. When a thrombus forms very rapidly, as in cases where a vein has been divided across and the circulation through it is completely obstructed, the clot is black or dark red in colour, is uniform in structure and lies loose in the vessel or is only slightly adherent to the inner surface of the vein. This is known as the *coloured thrombus.* When, on the other hand, the coagulating process takes place gradually, as in cases where some alteration in the lining membrane of the vein causes the leucocytes to adhere to it, the resulting thrombus is greyish white ; it is laminated in structure and is adherent to the lining membrane of the vein. This is known as the *colourless thrombus.* In the majority of cases, however, the clots are of a mottled appearance; a part, that first formed, being decolourised, and the rest, subsequently formed around it, of the coloured variety. These are known as *mixed thrombi.*

The fate of the thrombus.—The changes which may take place in a thrombus are several, and depend in a great measure upon the causes which led to its formation and the circumstances under which it is placed. The changes are as follows : (1) *Organisation.* Here the changes are very much the same as those described as occurring in an artery (page 288). There is a proliferation of the cells of the endothelial lining of the vein. These proliferated cells invade the clot, replace it and form a connective tissue, which becomes vascular and occludes the vessel. (2) *Canalisation.* This is a further change in the plug formed in the process of organisation ; by its shrinking and cleavage a space may be left in the clot, which may enlarge and form a continuous channel, and the circulation through the vessel may be restored. This channel may be situated in the centre of the clot, or at one side, when the remains of the clot or the fibrous tissue that has replaced it will appear as a thickened patch on one side of the vein. (3) *Disintegration.* The clot may soften, disintegrate, and be washed away in minute particles into the circulation. The clot begins to soften and liquefy in its centre, and the process gradually extends through the whole mass until it becomes converted into a creamy fluid which resembles pus, but is not pus. Microscopically it consists of granular débris and a few white corpuscles, which have escaped disintegration. These are carried into the blood stream, and some of the granular débris may be arrested in the capillary circulation, but if aseptic and unirritating give rise to no symptoms and cause no inflammation. When the clot is infective or septic phlebitis of the wall of the vein exists, the disintegrated clot consists of granular débris, pus cells, and micrococci. When these are carried into the blood stream and become lodged in the capillaries of the lungs or elsewhere, they form infective emboli and give rise to secondary abscesses (see page 170). (4) *Calcification.* Small portions of the clot may remain in the pouches behind the valves of a varicose vein, and may become converted into fibrinous masses, which ultimately undergo calcification. These are termed *phleboliths.* (5) *Embolism.* A large portion of the clot may become separated off from the rest, and may be carried into the blood stream and impacted in the pulmonary artery or one of its branches, constituting *pulmonary embolism.* This often arises from a portion of the extremity of the clot which may project over the mouth of the first collateral branch becoming detached by the current of the blood (fig. 113), or it may be caused by careless handling or the movements of the patient. If the clot is of large size so as to entirely block the main pulmonary vessel, instantaneous death is the result ; if it is smaller so as to become lodged in one of the large branches of the pulmonary artery, sudden pain with intense dyspnœa is complained of. This is followed by hæmoptysis and the signs of a local consolidation of the lung. If the clot is aseptic the patient will in all probability recover. If minute fragments are set free, no symptoms are produced.

Symptoms.—The symptoms of thrombosis are those of obstruction of the vein: swelling and œdema of the parts from which the vein affected derives its tributaries. The part is swollen, white and pasty, and pits deeply on pressure. The superficial veins are enlarged. If the thrombosed vein is a superficial one, it will be felt as a hard cord with enlargements corresponding to the position of the valves. The patient usually complains of stiffness of the limb, rather than pain, though in some cases the pain may be severe and the part is always tender on handling. If the thrombus is complicated with phlebitis, there will be in addition the classical signs of inflammation and some elevation of the temperature. The treatment will be considered with that of phlebitis.

Phlebitis.—Inflammation of veins may be of two kinds, viz.: (1) Simple or plastic, and (2) Diffuse or infective.

1. **Plastic phlebitis** may arise from many causes. (*a*) From injury to the coats of the vein; (*b*) from the formation of a thrombus within the vein; (*c*) from extension from inflammation of the tissues around; (*d*) from gout; (*e*) or it may be idiopathic in its nature, in which no definite cause can be determined, though it generally attacks the veins of the lower extremity, which have been long affected with varix.

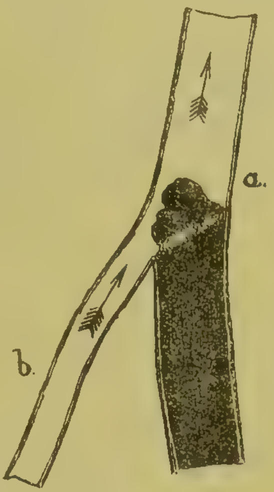

FIG. 113.—Thrombosis of vein. *a*, portion of the clot, projecting from the mouth of the vein and becoming detached; *b*, collateral branch, with arrow showing the course of the circulation.

Pathology.—The first effect of the inflammation is to produce changes in the intima, which cause the blood to clot and a thrombus to form. This is limited, usually only extending a few inches up the vessel, and shows no tendency to spread. The external and middle coats become swollen and infiltrated with round cells, the endothelial cells of the intima proliferate and invade the clot, and the vessel undergoes the same changes as occur in thrombosis; organisation may take place and the vessel be converted into an impervious cord, or the inflammation may subside, the clot disintegrate, and the vein be restored to its former condition. The surrounding tissues are usually involved and œdematous.

Symptoms are those of thrombosis, plus inflammation. A hard cord is to be felt in the course of the vein, with an indistinct outline. The skin over it is red, and there is pain and tenderness on handling. The part is sensibly hot to the touch, and there is usually a rise in temperature.

Treatment.—The treatment of thrombosis and plastic phlebitis is the same, consisting mainly of complete and absolute rest. The patient should be confined strictly to bed, with the limb lightly fixed to a splint, and raised above the level of the body, so as to promote the return of the venous blood. All examination or handling of the part should be interdicted, for fear of displacing a portion of the clot. Much relief may be given to the pain by the application of warm Goulard lotion with opium; but there is an objection to this plan of treatment, because it requires constant renewal and handling of the limb. Perhaps a better application is to paint the part over freely with a mixture of equal parts of extract of belladonna and glycerine, and then swathe the limb in a thick layer of medicated wool, which may be lightly bandaged on. The internal administration of an alkali (potassium bicarbonate) to render the urine neutral or slightly alkaline is of use, especially in the gouty form of the disease. When all inflammatory symptoms have subsided and sufficient time has been allowed for the organisation or removal of the clot, massage should be employed in order to get rid of the œdema and inflammatory thickening which has taken place.

2. **Infective phlebitis.**—The suppurative form of phlebitis is a much more serious condition than the plastic form. In it the walls of the vein and the thrombus contained in the vein are infiltrated with pyogenic organisms. The disease may begin in the coats of the vessel, as a phlebitis, its wall becoming infected with septic material from an infective inflammation of the tissues in the neighbourhood; or a thrombus may first form and the organisms may then invade the clot and from it spread to the wall of the vessel, or the clot itself may be septic, the infective material having been carried in the circulating blood from some distant focus of infection. In whichever way formed the clot undergoes puriform softening and the products blend with those of the disintegrated vessel. Fresh thrombi form above the first one, and these in their turn break down and become puriform, and in their disintegration portions of the clot are often dislodged and are carried in the blood stream to other parts, where they become lodged in the arterioles and form emboli, which, being infected with septic matter, form secondary abscesses, and thus a general condition of pyæmia is established. In many cases the infection spreads from the vein to the tissues around, and suppuration takes place in these tissues. The disease occurs in connection with septic wounds, and especially in septic inflammation of bones, such as acute necrosis, or osteo-myelitis after amputation and compound fracture. It is now almost banished as a sequel to surgical operations, though formerly, before the introduction of antiseptic surgery, it was of very common occurrence.

In some cases the infected thrombus may be localised by a plastic phlebitis taking place in the vessel on the cardiac side of the infected area. This seals the vessel at this point and prevents the passage of the septic material into the general circulation. In these cases local suppuration occurs at the infected area, but no general pyæmia results.

Symptoms.—When the disease attacks a superficial vein, the symptoms are sufficiently obvious: a solid cord will be felt, with enlargements, corresponding to the position of the valves, the skin around is dusky red, and the tissues more or less infiltrated with inflammatory effusion, so as to a certain extent to obscure the outline of the vein. There is pain and tenderness along the course of the vessel and œdema of the parts below. After a time the hard cord becomes softer, and eventually fluctuation will be detected and all the symptoms of acute abscess. The disease may be limited in those cases where a plastic phlebitis is present beyond the area of infective phlebitis, but in many cases the inflammation may be traced rapidly creeping up the vein. When the disease is situated in one of the deeper veins, the symptoms are much more obscure, and indeed the disease may not be suspected until the grave symptoms of septicæmia and pyæmia show themselves, but acute deep-seated pain with marked œdema should always lead the surgeon to suspect this condition in cases where a septic wound is present.

Accompanying these local signs there is fever, characterised by a high temperature, with rapid, weak pulse ; a dry tongue ; and often low muttering delirium. These are followed by repeated rigors, with an intermitting temperature, when pyæmia is set up.

Treatment.—The only treatment for this affection is to thoroughly get rid of the whole of the septic material. If this can be done early, before general infection has taken place, the results are most gratifying. Unfortunately this cannot always be done ; the disease is not seen until more than one vein has become affected or until the disease has extended so far that the condition cannot be satisfactorily dealt with. The treatment consists in at once exposing and, after ligature, laying open the vein throughout the whole length which is inflamed, turning out the whole of the infective clot, and swabbing out the vessel with a strong solution of corrosive sublimate (1 in 500) or pure carbolic acid. The vein is then to be stuffed with antiseptic gauze. If the deeper veins are affected and this cannot be done, the only resource, if the disease is recognised before general infection has taken place, is to amputate well above the inflamed vein.

Varicose veins.—A vein is said to be varicose when it is permanently dilated, as the result of certain degenerative changes in its coats. Scarcely any veins are exempt from this condition, but it is infinitely more common in some situations than others. The three most common situations in which it is found are the subcutaneous veins of the lower extremity, the spermatic veins, and the hæmorrhoidal veins. In other situations true varix is rare, though simple dilatation from obstruction to the return of venous blood from the pressure of a tumour or aneurism &c. is not uncommon. The one condition should be differentiated from the other ; dilatation in true varix is permanent and is accompanied by changes in the coats of the veins, but in simple dilatation the enlargement subsides if the cause is removed.

Causes.—The causes of varicose veins are anything which destroys the balance between the intravenous pressure and the resistance of the walls of the vein. Increased blood pressure in the veins may arise in several different ways : the action of gravity in prolonged standing ; habitual over exertion of a limb, by increasing the supply of blood to it ; any obstacle to the return of venous blood, as the pressure of a tumour, or the gravid uterus, or tight gartering, tends to cause an accumulation of blood in the veins of the lower extremity and so produce varix. The diminished resistance of the walls of the vein may be and often is an hereditary condition, but may arise also from inflammatory changes in the coats of the veins, leading to softening, or from absorption of surrounding tissues which deprives the vessel of its accustomed support. In some cases the condition appears to be due simply to an enfeebled state of the walls of the vessel occurring in debilitated individuals.

Pathology.—The first effect of any of the above-named causes is to produce a dilatation of the vein. If the cause is speedily removed, the natural elasticity of the tissues around, which support the vein, as well as of the vein itself, causes complete recovery, and the vessel regains its natural size ; but if the cause is not removed changes take place in the coats of the vein which result in its permanent dilatation, from which it never undergoes spontaneous cure. It should be mentioned that the vein not only undergoes dilatation of its calibre, but also elongation ; and as the ends of the vein are fixed points, this accounts for the very tortuous course which these dilated veins assume. Pouches also not infrequently form in these dilated veins, and though usually small, may attain the size of an egg (fig. 114). The change in the coats of the vein principally takes place in the middle coat, and is due to the development in it of a dense fibroid tissue, and in addition to this the muscular tissue is increased in quantity. The internal coat undergoes little thickening, but presents a striated appearance and occasionally calcareous patches. The external coat is also thickened, but not to the same extent as the middle. The valves, which consist of a reduplication of the inner coat, are not thickened, and in fact in some instances disappear altogether or remain only as flattened bands resting against the wall of the vein : from this it follows that when dilatation has taken place, the intravenous tension is increased, because the column of blood is unbroken by the incompetent valves. In the pouch-like dilatations the middle coat becomes atrophied, and its walls are reduced to a condition of extreme thinness.

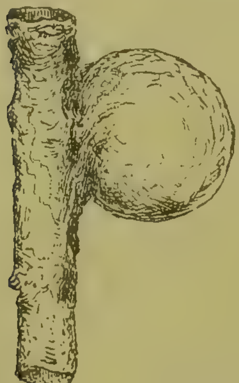
FIG. 114.—Pouch-like dilatation of the internal saphenous vein. (From a preparation in the Museum of St. George's Hospital.)

Effects of varicose veins.—In consequence of the dilated condition of the veins the current of blood through them is slowed and retarded, and its due return interfered with ; as a result of this there is a passive congestion set up in the parts from which the tributaries of the vein are derived. This causes œdema, from the transudation of the watery parts of the blood from the loaded vessels ; induration, from the coagulation of the effused fluid ; pigmentation, where some coloured corpuscles have escaped from the vessels, and becoming broken up have left their pigments behind ; and malnutrition from the defective circulation. In consequence of the imperfect nutrition, ulceration frequently takes place, and varicose veins are one of the most prolific causes of ulcer of the leg (fig. 115). In consequence of the congestion of the skin, eczema is a frequent effect of varicose veins. Another complication which may occur as the result of varicose veins is rupture. This is partly due to a thinning of the walls of the vein from pressure within, partly to thinning of the skin and subcutaneous tissues from pressure of the varicose vein upon them ; conjoined with this there is often a process of ulceration going on, which gradually extends and implicates the thinned wall of the vein, and it eventually gives way, and hæmorrhage results. Another effect of varicose veins is that thrombosis may occur ; this probably takes place as the result of an inflammation being set up in the coats of the vein, a condition to which they are very prone.

Symptoms.—Varicose veins are easily to be recognised when they are subcutaneous. The deep veins, which are less frequently varicose, give rise to no symptoms by which they can be diagnosed. The superficial varicose veins may present two different conditions. In one a single main trunk, e.g. the internal saphenous vein, may be enlarged (fig. 116). It then stands out as a thick, bluish, tortuous cord under the skin ; it feels thick under the finger, and if the patient is in the erect position, stands out in bold relief ; if, on the other hand, he is in the recumbent position, and the limb is raised, it partially or almost completely disappears. In other cases the small superficial veins are affected and form a close network of vessels of a purplish colour in the skin, producing considerable discolouration. There is often an impulse on coughing to be felt in the vein, sometimes as low down as the knee, seldom lower. The patient complains of a dull, aching pain, especially after standing for some time or after taking active exercise, with a sensation of fullness. Occasionally cramp is complained of.

Treatment.—The treatment of varicose veins may be either palliative or curative, but there are some cases in which no treatment whatever is required. Where the patient suffers no inconvenience or discomfort from them he may be safely left alone, at the same time being cautioned to watch them carefully and see that they do not increase or other veins become involved. The *palliative* treatment consists in supporting the dilated vein by an ordinary soft bandage, by an elastic stocking, or by a Martin's bandage. If an ordinary bandage is used, care must be exercised to apply it evenly; if an elastic stocking is used, it must be seen that it fits accurately. The Martin's bandage makes efficient pressure, but is objectionable because it retains the perspiration and induces eczema; if

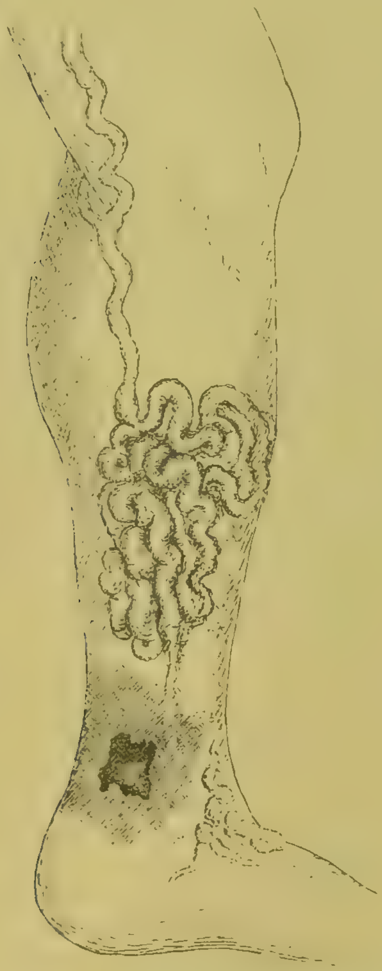

FIG. 115.—Varicose veins and ulcer of the leg. (From a drawing in the Museum of St. George's Hospital.)

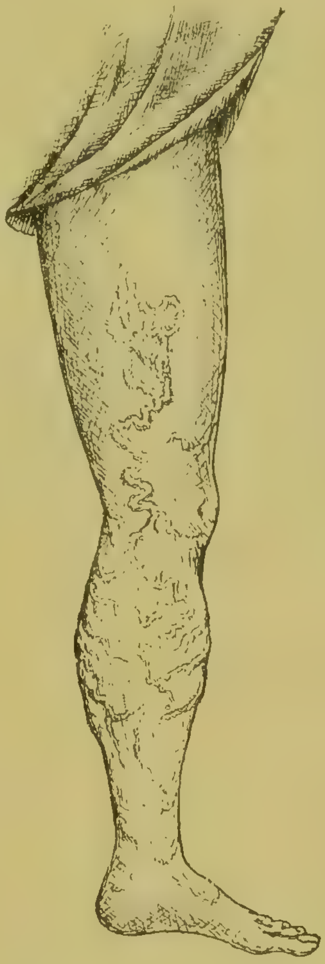

FIG. 116.—Varicose veins of the lower extremity. (From a photograph.)

one is used, it should always be perforated. Whichever plan is adopted the patient should be cautioned always to apply the pressure when the veins are empty, either before he gets up in the morning, or by lying down and raising the limb for some minutes before the bandage or stocking is applied. The *curative* treatment consists in obliterating the vein by operation. It should only be resorted to in selected cases and after the palliative treatment has had a fair trial and failed—in patients who are in good health, not advanced in life, where the veins cause pain and discomfort which is not relieved by compression; where a vein is likely to burst and where the varicosity is chiefly confined to one vessel. Many plans have been resorted to for obliterating the veins, such as subcutaneous division, acupressure, ligature, the actual cautery, &c.; but they are all inefficient, because they all aim at obliterating the vein at a single point. This they no doubt succeed in doing, but a collateral circulation is rapidly set up, and very soon there is a return of the disease. The only efficient way of curing varicose veins is by their excision or partial excision, and with rigid antiseptic precautions the operation may be performed without any fear of evil consequences, and is followed by the most satisfactory results. The operation may be performed by removing the whole of the varicose vein from end to end, or by removing about an inch or an inch and a half in several places. My own experience would lead me to say that the more of the vein removed the better for the patient; the risk of the operation is not materially increased, the time occupied in its performance is not greater, and the results in my hands have certainly been more satisfactory. The operation is performed by first of all seeing that the limb is most rigidly cleaned and dressed for some hours with gauze wrung out in an antiseptic solution. The position of the vein should be marked out with an aniline pencil, with the patient in the erect position, if there is any difficulty in accurately defining it. A longitudinal incision is made over the vein, and the vessel exposed in its whole length and separated from surrounding structures. A catgut ligature is then placed round the vessel at its cardiac end and tied. The vessel is seized just below with a pair of clip forceps to prevent its bleeding, and divided between the ligature and clip. It is raised from its bed, each collateral branch being seized with clip forceps as it is pulled up and divided until the lower end of the incision is reached. The vein is now tied here and removed. The wound is sutured with a continuous suture of horsehair, dressed, and placed upon a back splint with a foot piece. It occasionally happens that in a case of varicose veins requiring operation, there is also a varicose ulcer; under these circumstances the patient should be confined to bed, and the ulcer treated and healed before any attempt is made to excise the vein.

Trendelenburg recommends in certain cases of varicose veins the ligature of the internal saphenous vein in the thigh as a means of cure. He says that there is a variety of varicose veins in which the varicosity first appears in the saphenous trunk, and in these cases, if the patient is made to lie down and the limb is raised in order to empty the varicose veins, and pressure is made on the vein as it passes through the saphenous opening, and the patient then again assumes the erect position, the varicose vessels will not become distended. For these cases he recommends ligature high up in the vein. Favourable results have been said to follow the operation.

ANGIOMA

By the word **angioma** we mean a tumour composed of an abnormal formation of blood-vessels and consisting mainly of these structures. When the arterial system is principally or exclusively involved, the disease is spoken of in general terms as a *cirsoid aneurism*; but when the veins and capillaries are for the most part implicated, the term *nævus* is applied to the tumour.

Cirsoid aneurism.—Though the term cirsoid aneurism is applied to those forms of angiomata where the arteries are mainly at fault, there are three different conditions included under this head to which different names have been given. When the disease involves a single artery, which becomes dilated, with pouch-like sacs, and is elongated and tortuous, the term *arterial varix* is applied from its resemblance to a varicose vein (fig. 117). When a number of small arteries become dilated, elongated, and tortuous, forming a tumour composed of a collection of these vessels packed together, the disease is termed a *true cirsoid aneurism*. And finally, when there is dilatation of the veins and capillaries of the part, as well as the arteries, so that the tumour is composed of all three classes of vessels, the term *aneurism by anastomosis* or *plexiform angiomata* is applied. These three conditions are, however, closely connected together, and in practice are often indistinguishable from each other. The disease is a rare one, and most frequently affects the arteries of the scalp or those of the orbit, but isolated cases have been recorded where it has occurred on the trunk and limbs. In most of the cases there is the history of some injury, as a blow. They most often make their appearance in a young adult, though they may occur at any period of life, and occasionally originate in a nævus.

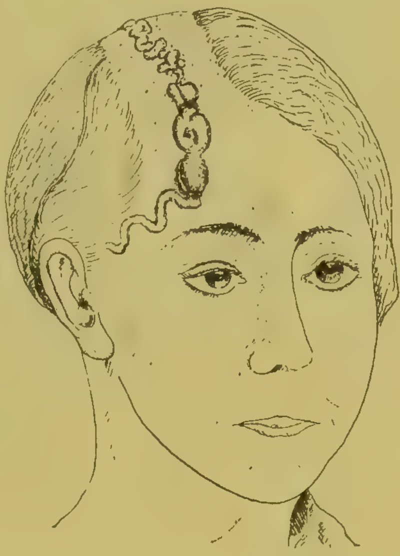

Fig. 117.—Arterial varix. (From a drawing in the Museum of St. George's Hospital.)

Pathology.—The disease appears to consist principally in an atrophy of the middle coat of the arteries involved, though all the coats of the vessels are thinner than natural, and conjoined with this the arteries become dilated, and assume a varicose condition, being dilated into small sinuses. When occurring on the scalp the skin over them becomes thinned, and the subjacent bone may be absorbed.

Symptoms.—They form tumours of varying size and irregular shape, which are soft, compressible, and not distinctly circumscribed. There is a distinct pulsation in the tumour, and a peculiar vibratory thrill. Upon listening with a stethoscope a bruit can be heard, which varies in character, sometimes being loud and harsh, and at others soft and purring in character. Numerous large pulsating vessels can usually be traced into the tumour. When the form of disease is the arterial varix, a single, enlarged tortuous artery may be seen and felt pulsating under the finger. When the disease is the true cirsoid aneurism there is a more or less irregular ill-defined swelling, with a strong expansile pulsation and a loud rasping bruit, and very much the same condition is found in the aneurism by anastomosis, for these two conditions cannot be distinguished from each other. They may, however, be distinguished from arterial varix by the fact that in this disease pressure on the feeding artery arrests pulsation in the swelling, whereas in the cirsoid aneurism and the aneurism by anastomosis, which are fed by many arteries, pressure on *one* spot will not stop the pulsation. These different forms of arterial angioma are of a dangerous character, as their natural tendency is to increase and grow rapidly, causing thinning of the structures superficial to them, and, eventually bursting, to cause death from hæmorrhage. Sometimes, however, they may remain stationary, and have been known to undergo spontaneous cure.

Treatment.—When they show no tendency to increase, all that is necessary is to protect them from injury. This is best done by having a light metal cap, preferably of aluminium, moulded to the swelling, which should always be worn. If, on the other hand, the tumour shows a tendency to increase, operative interference must be undertaken. If the tumour is of no great size, and is fairly circumscribed, excision holds out the best prospects of a cure. This must be done with great caution, cutting widely of the dilated vessels, and ligaturing or clamping each artery as it is cut. Some recommend, instead of excision, that the tumour should be strangulated by a ligature; this avoids the risk of hæmorrhage, but is not nearly so certain in effecting a cure. In cases where the disease is of considerable extent and cannot be treated by excision or strangulation, I believe that electrolysis holds out the best hope of a cure. It has been recommended to tie all the feeding arteries, but, as far as I know, the operation has never been attended with success; or to tie the main artery. If the disease is on the scalp, one or both external carotids may be tied, but the treatment is not satisfactory, as the aneurism may still be fed by the branches of the ophthalmic artery. Ligature of the common carotid should not be performed, as the results have been most unpromising. If the disease is in one of the limbs, the main artery, brachial or femoral, may be tied with a fair prospect of success. Injection with perchloride of iron has also been advocated, a temporary ligature having first been placed round the tumour.

Nævus.—A nævus is that form of angiomata in which the veins or capillaries are principally involved, and they are usually divided according to their structure into the capillary or simple and the venous or cavernous. But the most common condition is to find the two forms combined: the most superficial part of the nævus, namely, that affecting the skin, being capillary; while the deeper part, that in the subcutaneous tissue, is venous. Little or nothing is known of the cause of nævi, except that they may be hereditary. Most nævi are congenital, though they may not be first noticed until shortly after birth. Cases have been recorded in which they have been said to develop after an injury. They may grow in all parts of the body, but principally in connection with the skin and subcutaneous tissue, or mucous membranes at the orifices of the body.

The **simple** or **capillary nævus** is a common form. It is principally met with in the superficial layers of the skin, especially that of the face and scalp, and upper part of the chest. It is composed of a congeries of capillary vessels, greatly increased in size and number. It appears as a small bright red patch, which may sometimes project slightly from the surface. The capillary nævus is popularly known as 'mother's mark.' It is often multiple, may grow slowly or rapidly, or it may show no tendency to increase, and may disappear within a few months of birth. Occasionally the nævoid tissue spreads through the papillary layer of the skin, and a considerable area of this structure may be involved, causing a red discolouration, which is known by the name of *port-wine stain*.

Treatment.—When of small size, the best plan of treatment is to apply a solution of corrosive sublimate collodion (1 in 8 to 1 in 12). The healthy skin around is first to be painted over with flexile collodion, and this is to be allowed to dry before the corrosive sublimate collodion is applied, in order to protect the skin. The part is then brushed over two or three times with the solution, which is allowed to dry. The pellicle formed is left to separate of itself, and when it falls off a white scar is left. Occasionally, if the solution is too strong, there is a little ulceration; this should be avoided if possible. If the nævus is of larger size, this plan of treatment is not sufficient, and it will be necessary to apply fuming nitric acid or touch it with the point of Paquelin's cautery. The fuming nitric acid is perhaps the better application of the two. The skin around should be brushed over with olive oil to protect it, and then a drop of the acid is to be applied to the surface of the nævus with a piece of finely pointed stick or a pointed glass rod. The acid is allowed to remain on until it is judged that it has burnt deeply enough to destroy the growth, and then a thick paste of chalk in water applied. Port-wine stains are not amenable to treatment.

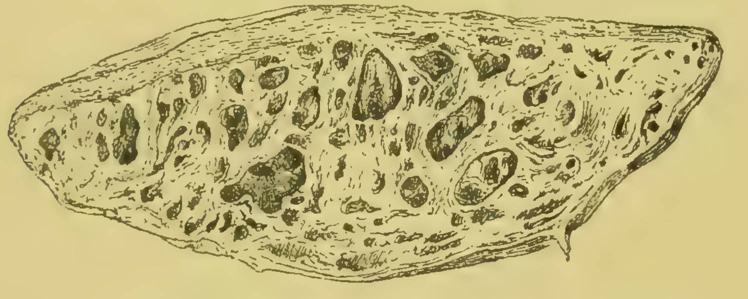

FIG. 118.—Section of a nævus, showing its structure.
(From a drawing in the Museum of St. George's Hospital.)

The **venous** or **cavernous nævus** is generally subcutaneous, and may occur in any part of the body. It is often surmounted by a capillary nævus, which affects the skin over it. It is frequently multiple, and may attain a considerable size, forming a distinct tumour, which is soft, may be diminished by pressure, and is lobulated. When situated in the subcutaneous tissue entirely, it may present a dark purple or bluish colour through the thinned skin over it. It becomes fuller and tenser during straining or crying.

The venous nævus on section presents a sponge-like appearance, being composed of spaces lined by endothelium similar to that found in veins (fig. 118). These spaces are connected together by delicate areolar tissue, and the whole is inclosed in a thin fibrous capsule. The cavities are produced partly by dilatation of the veins and partly by dilatation of the capillaries.

Nævi rarely produce any serious ill effects. They may remain stationary for years, without showing any disposition to grow, and may eventually disappear, or they may increase with great rapidity. They may undergo secondary changes in the course of their growth. This may consist in a process of ulceration, which, commencing in their centre, gradually spreads to the periphery and cures the disease. Or the areolar stroma may increase, and by its increase may press upon and obliterate the cavities, and the whole growth may be converted into a solid fibrous mass. Or they may undergo a cystic change, and the tumour become converted into a blood cyst, probably owing to the shutting off of one of the spaces and its subsequent distension. Nævi are sometimes associated with an increased development of fatty tissue, and are then termed *nævo-lipomata.*

Treatment.—Cavernous nævi only require treatment when they are growing; if they show no tendency to increase, they should be left alone in the hope that they may disappear. If the nævus is entirely subcutaneous the best plan of treatment is excision. If care is taken not to open the thin capsule this can be done with very little hæmorrhage and without any great difficulty. The edges of the wound are then sutured, and will in all probability unite by first intention and leave nothing but a linear scar. If the nævus is not entirely subcutaneous, but is complicated with a capillary nævus of the skin, this plan of treatment is not always possible, as it would involve the sacrifice of too much of the skin. When the skin is only involved to a very slight extent, the portion implicated may be included in two elliptical incisions and the whole growth excised. It must be borne in mind, however, that every particle of the nævoid tissue must be removed, otherwise the disease is sure to recur.

When excision cannot be undertaken, electrolysis is the best substitute for it. The best form of battery to use is one of Leclanché's (sal ammoniac cells), and not more than ten cells should be used, as the most successful results will be obtained by a slow, weak action continued for some time. The needles, which are of platinum, should be insulated to within half an inch of their points. One needle should be connected with the negative pole, and several with the positive pole. They should be thrust into several parts of the growth before the current is passed. This should be done gradually, and the current slowly increased until little bubbles of gas are seen issuing from the minute punctures; when this is observed, no further increase is required. The current should be allowed to pass from ten to fifteen minutes, and the position of the needles shifted once or twice during the process. At the end of this time it will probably be noticed that the tumour is sensibly harder and more solid. Before withdrawing the needles, the current should be reversed for a minute, as this will materially lessen the chance of bleeding afterwards. If there should be any, it can always be arrested by a little pressure from a pad and bandage. The object of the operation is to cause the blood to coagulate, but not to cause necrosis of the tissues, so that in this way nævi may be cured without leaving any scar except the punctures made by the introduction of the needles. The operation is a painful one, and therefore anæsthesia is required, and in all probability it will be necessary to repeat it, perhaps more than once, before a cure is effected. No attempt should be made to do too much at a time.

Many other plans have been advocated for curing nævi. In former times the ligature was much resorted to, in order to strangle the nævus and cause it to slough off. Many different methods were in vogue for using the ligature, but it is scarcely necessary to allude to them, as this plan of treating nævi is in the present day scarcely ever resorted to. It leaves a large scar, which often causes deformity from its contraction; it is attended with suppuration, with all its attendant risks; and it frequently necessitates the sacrifice of healthy tissues. Injection of coagulants, such as perchloride of iron, pure carbolic acid, and solution of tannin, have been recommended, but are dangerous on account of the risk of embolism.

One method which I have adopted in one or two instances when the treatment by electrolysis or excision seemed to be contra-indicated, may be mentioned. It consisted in encircling the nævus, or a part of the nævus, when it was of very large size, with a subcutaneous ligature, applied sufficiently tightly to constrict the vessels, but not to completely strangulate the tumour, and then passing threads soaked in perchloride of iron through the growth in every direction. By this means I succeeded in curing a nævus which involved the whole of one side of the face, and was growing very rapidly, without any very serious amount of deformity. This method should be, however, reserved for very exceptional cases.

INJURIES AND DISEASES OF LYMPHATICS

Wounds.—Being widely distributed, lymphatic vessels must, of course, be frequently injured, but as a rule no serious results follow. Their walls collapse from pressure of surrounding tissues, and the valves prevent any backward flow until the ends are firmly sealed by the lymph which coagulates on their surface. Occasionally this does not take place, and lymphatic fistulæ may be formed, producing a condition which is known under the name of *lymphorrhœa*—a discharge of a thin, colourless fluid, which speedily coagulates into a gelatinous film.

Lymphorrhœa may also be caused by obstruction taking place in the lymphatic vessels or glands from inflammatory changes, and the subsequent discharge of the lymph from the engorged vessels, which are opened up by ulceration. The discharge issues from many points, is intermittent in character, being increased by exercise and diminished by rest and elevation of the limb. It may amount to several ounces in the twenty-four hours.

Injury to the thoracic duct.—Cases have been recorded in which the thoracic duct or receptaculum chyli has been injured in gunshot wounds and bayonet thrusts; and also cases in which it has given way from obstruction to the passage of its contents by the pressure of a tumour, or by constriction from inflammatory changes, or from its orifice, where it opens into the subclavian vein, becoming blocked by a fibrinous vegetation. In these cases it is the receptaculum chyli which usually bursts. Sir Astley Cooper tied the thoracic duct in a considerable number of dogs, and in every case but one the receptaculum chyli gave way. The diagnosis in these cases is impossible, except where there is an external wound and a milky fluid escapes. Death may take place rapidly from peritonitis, or the patient may live some weeks, finally succumbing to marasmus.

Congenital defects of the lymphatics.—Certain congenital defects of the lymphatics occasionally give rise to the formation of a variety of cystic tumour, which has already been described (see page 231) under the name of *cystic hygroma*. Another form of congenital defect of the lymphatics of the tongue gives rise to a condition of hypertrophy of its tissues, which is known under the name of *macroglossia*; this will be described with diseases of the tongue. A somewhat similar condition sometimes affects the lips, and is called *macrocheilia.*

Varix of lymphatic vessels.—The lymphatic vessels may become dilated, with hypertrophy of their walls. This would appear to be the result of obstruction from the pressure of a tumour in most instances, as, for example, an aneurism pressing on the thoracic duct; or a malignant growth in the groin pressing on the vessels in this situation. When the larger vessels are affected, they form cystic spaces, lined with epithelium, and to them the term *lymphangeioma* is applied. When the smaller vessels become varicose, they present slight elevations on the surface of the skin, which give it a roughened appearance, which has been compared to the rind of an orange. This condition, which is named *lymphangiectasis*, is most frequently met with along the course of the lymphatics on the inner side of the thigh. The dilated vessels may burst, giving rise to lymphorrhœa.

Lymphangitis (*Angeioleucitis*).—These terms are applied to an inflammation of a spreading or diffuse character which attacks lymphatic vessels. It arises from the presence in the vessels of some septic material derived from decomposing tissues or the products of an infective inflammation affecting the tissues from which they derive their lymph. It is therefore very commonly associated with cutaneous erysipelas, and also occurs from some slight wound or scratch, into which some septic products of decomposing material have found an entrance. The disease is common among butchers, cooks, and those who are engaged in making post-mortem examinations. A wound or abrasion is in most instances present, though it may be so minute as to escape the observation of the surgeon. The disease is predisposed to by anything which impairs or vitiates the general health. Habitual intemperance, neglect of proper hygienic surroundings, and albuminuria, all tend to induce it.

Pathology.—The inflammation attacks the coats of the vessel, which become much swollen and infiltrated with round cells. The intima becomes opaque and swollen, and the endothelium degenerates and desquamates. The inflammation extends from the coats of the vessel to the surrounding tissues, which become swollen and infiltrated. The contents of the vessel become cloudy and may coagulate. In many cases pyogenic organisms are mixed with the infecting virus, and then suppuration occurs.

Symptoms.—The patient is first of all conscious of a general feeling of malaise, and complains of alternate sensations of heat and cold, or he may in some cases have a distinct rigor, and this may be accompanied by diarrhœa and vomiting. An abrupt rise in the temperature up to 102° or 103° F. will be noted. He will complain of pain and stiffness extending up the limb, with acute pain and throbbing in the wound if there is one. Upon examination it will be found that the wound presents an unhealthy appearance and is surrounded by a red area. Radiating from this will be seen a number of fine red streaks, running in the course of the lymphatic vessels to the lymphatic glands, into which they empty themselves. The streaks are considerably wider than the vessels themselves, in consequence of the implication of the adjacent structures in the inflammation, and sometimes they are coalesced with each other so as to form a band, which presents a somewhat thickened sensation to the finger. In some cases the inflammation spreads to surrounding parts to such an extent as to give the appearance of erysipelas, and is often accompanied with more or less œdema. The glands into which the inflamed lymphatic vessels empty themselves speedily become enlarged. When the deeper seated lymphatics are implicated there is œdema along the whole or part of the limb, and deep-seated pain, and in some cases this may occur without any superficial redness. In these cases where the deep lymphatics are affected, without much implication of the superficial vessels, the glandular enlargement is often the first indication of the disease.

The disease may terminate in a few days in resolution, and the parts return to their normal condition. But if pyogenic organisms have been introduced with the poison, suppuration may occur either in the form of localised abscesses along the course of the lymphatics, or, what is perhaps more common, suppuration may ensue along the whole course of the vessel, and spreading widely may cause the formation of cellulitis extending up the limb. When this occurs a condition of solid œdema is apt to be left, which is very intractable and hard to cure. In some cases of lymphangitis, death results from general blood poisoning.

Diagnosis.—The only conditions for which lymphangitis is likely to be mistaken are erysipelas and phlebitis. From erysipelas it can at once be distinguished by the absence of the abrupt raised margin to the redness which characterises this disease; and from phlebitis by the brighter colour of the redness, the absence of the hard cord-like plugged vein, and the presence of the enlarged and painful glands.

Treatment.—In conducting the treatment of a case of lymphangitis, the wound from which the infection was derived must be thoroughly cleansed, and exit given to any locked-up pus. This must be done by removing any scabs which may be present, providing for free discharge, and by washing out the wound with a strong solution of corrosive sublimate (1 in 500); it should then be dressed with hot boracic lint. The superficial lymphatic inflammation is best treated by painting the inflamed area with a mixture of equal parts of extract of belladonna and glycerine, and then applying a hot fomentation. Or as an alternative treatment warm Goulard lotion with opium may be applied on lint under oil silk. The limb should be raised. In most cases it is desirable to commence treatment with a brisk mercurial purge, after which quinine or bark and ammonia should be given. As the fever has a tendency early to assume an asthenic form, the administration of a small quantity of stimulant may be called for. If abscesses form, they must be opened early. The œdema which sometimes follows this condition is best treated by the pressure of a Martin's bandage.

Lymphadenitis.—Inflammation of the lymphatic glands is almost always due to some septic material which is carried to them by the lymphatic vessels, and which, becoming lodged in them, sets up irritation and inflammation. This noxious material may be carried in the lymph without exciting any inflammation of the lymphatic vessels along which it is carried, and therefore no trace of its passage along these vessels may be evident. It has been proved by experiment that solid particles can pass along the lymphatic vessels, but that they cannot pass through lymphatic glands, but are arrested in their substance. In most cases of lymphadenitis these solid particles are definite microscopic organisms, which, being taken up into the lymphatic vessels, are carried along in the lymph stream until they reach the first lymphatic gland in the course of the vessels, and here they are arrested, and, setting up irritation, inflammation of the gland is the result. But, as described in the preceding section, in some cases the inflammation in the gland is excited by the direct extension of the spreading inflammation of the lymphatic vessels to the glands. Inflammation of lymphatic glands may be acute or chronic.

In the **acute form,** when inflammation attacks a gland it becomes swollen and infiltrated with round cells. It is softer than natural and of a red colour. Then yellow spots appear, both in the medullary and cortical portion, denoting points of suppuration. These increase and coalesce, and after a time the whole of the interior of the gland becomes converted into a bag of pus. The capsule partakes in this inflammatory condition, and the inflammation spreads from this to the connective tissue around, setting up a *periadenitis.*

Symptoms.—The symptoms are those of ordinary inflammation—pain, heat, swelling, and if the gland is a superficial one, redness of the skin over it. The swelling is at first circumscribed, and the enlarged gland can be distinctly isolated and defined, but very soon the inflammation in the tissues around obscures the outline of the gland and a somewhat diffused swelling is formed. The pain is generally at first of a dull aching character, then becomes more acute, and when suppuration is taking place, of a throbbing character. All movement of the part increases the pain. When suppuration has taken place, œdema appears in the tissues over the swelling, which becomes softer, and after a time fluctuation is perceived. Accompanying these local signs there is always more or less pyrexia, and on the occurrence of suppuration there may be a rigor. In some cases the symptoms are less acute, and the disease assumes a *sub-acute* form. The glands become enlarged and painful, and matted together by inflammatory exudation into the structures around. This forms an indurated, diffuse swelling, in which individual glands can scarcely be defined. Suppuration slowly ensues, and appears to take place for the most part in the tissues around the gland, so that it not infrequently happens that when one of these abscesses is opened, the gland will be found lying in a bag of pus and more or less isolated by the suppuration which has been going on around it.

Treatment.—In the treatment of lymphadenitis, the cause of the trouble must first be attacked and removed. The source from which the poison is derived must be detected, cleansed, and if necessary scraped, so as to prevent any further absorption of the noxious material. If suppuration has not yet taken place, hot boracic fomentations should be applied, or glycerine and belladonna. This will relieve pain, and if no further poison is allowed to be absorbed, may prevent suppuration. But if matter has already formed, as indicated by softening in the centre of the gland, an incision should at once be made into its interior; all necrosed tissue removed with a sharp spoon, the part dusted with iodoform, and a drainage tube inserted. When the disease is very subacute, perfect rest, after removal of the cause, may induce the swelling to subside without suppuration taking place. But the disease often runs a very long course, slowly breaking down and suppurating, and the recovery of the patient is materially hastened by excising the gland.

Chronic or **tuberculous lymphadenitis.**—The chronic form of lymphadenitis is a tuberculous condition occurring in patients who are of a tuberculous diathesis, and principally in children. It may occur in any glands, but is most frequently met with by the surgeon in the glands of the neck. It may be and often is the sequel to a sub-acute lymphadenitis: that is to say, from some slight cause an inflammation is set up in a gland which in a healthy subject would subside spontaneously, but which in a tuberculous individual alters the condition of the gland to such a degree that it becomes a favourable nidus for the growth of the tubercle bacillus; this finds an entrance, and the simple inflammation becomes a tuberculous inflammation (see page 205). Then the changes already described take place; the tuberculous material caseates and forms a cheesy fluid, within a thickened capsule. The curdy pus thus formed, if left to itself, gradually finds its way to the surface, involves and destroys the skin, and the matter is discharged, leaving an unhealthy cavity, in which are remains of the broken-down gland structure. This is slow to heal, and when it does leaves a puckered scar and great deformity.

Symptoms.—Tuberculous disease of the lymphatic glands is most common in the neck, and occurs principally in children and young adults. The disease begins as an insidious and painless enlargement of one or more glands, often without any evidence of primary lesion in those parts from which they derive their supply of lymph. In other cases there is evidence in the shape of some eruption about the scalp or face; pediculi capitis; carious teeth; or some irritation about the mucous membrane of the mouth or throat; or, failing these, some lesion of the mucous membrane of the nasal or aural cavities; and in those cases where no primary lesion can be found, it is nevertheless probable that some lesion has existed, and that the irritation has been conveyed from this to the glands. The enlarged glands are at first freely movable and clearly defined; as, however, the inflammation progresses, it extends from the gland to the tissues around, and they become fixed to neighbouring parts. If several glands are affected, they become fused together and form a large indurated and nodulated mass. The increase in size is slow, and sometimes the enlarged glands may remain stationary and cease to enlarge. The glands are at first quite solid; but after a time they will be felt to become softer in their centre, and then fluctuation will be detected. They now become adherent to the skin, which becomes thin, purplish, and undermined, and eventually gives way by a small opening, and curdy pus is discharged. This discharge may continue for weeks and months; the thin and undermined skin melts away, leaving foul unhealthy ulcers, with undermined edges and a base composed of the remains of the caseated material. If these sores eventually heal, they leave unhealthy puckered cicatrices, which produce great deformity.

The **diagnosis** of this condition from simple chronic inflammation is in the early stage impossible; but the chronicity of the process, with the gradual occurrence of softening and the diathesis of the patient, will later on reveal the true nature of the case. Tuberculous lymphadenitis may be mistaken for lymphadenoma in the early stage of this latter disease, when only one chain of lymphatic glands is affected; but in this condition the enlarged glands are quite isolated, and show no tendency to become fused together, or to become adherent to surrounding parts. At a later period of the case, the enlargement of several groups of lymphatic glands in lymphadenoma renders the diagnosis easy.

Treatment.—In the treatment of these tuberculous glands, the first point is to ascertain, if possible, the cause of the irritation and remove it. A diligent search should therefore be made to find any such cause, and if found to get rid of it: carious teeth should be extracted; enlarged tonsils removed; or any eruption about the scalp or face treated. When this is done, the condition of the gland must be considered. If it is hard and freely movable, it will be a question whether it is still in a condition of simple lymphadenitis, or whether it has already become the seat of tubercle. If the former, it will speedily subside upon the removal of the irritating cause. In either case constitutional treatment should be adopted : change of air to the seaside ; the administration of cod liver oil, iodide of iron, &c. ; and regulation of the diet and excretions. On no account should friction with iodide of potassium liniment, or iodide of lead ointment, or painting with tincture of iodine, be allowed, and the friends should be cautioned against constantly handling the lump. The case should be carefully watched, and as soon as there is undoubted evidence of softening having taken place, the gland or glands should be excised before any periadenitis has caused fixation. If the operation is performed at this time it is not one of any great difficulty ; the capsule of the gland can be exposed, and by means of a director or blunt flat needle mounted on a handle its connections may be torn through and the gland removed without opening the capsule. If the operation is delayed until the gland has contracted adhesions to surrounding parts it will have to be dissected out, and this is an operation requiring great care in the neck, as important structures, especially the internal jugular vein in the anterior triangle and the spinal accessory nerve in the posterior triangle, are apt to be wounded. It sometimes happens that the surgeon is not consulted until after the skin has become implicated and the caseous gland has discharged its contents, and there are discharging sinuses in the neck. Under these circumstances the sinuses should be enlarged, and the cavity carefully and thoroughly scraped out with a sharp spoon. In doing this it will often be found that there is a small round opening in the cavity communicating with a caseating gland under the deep fascia. This opening, or openings if there are more than one, must be enlarged and the spoon introduced and the whole of the caseating tissue removed. After this is done the cavity is to be swabbed out with a solution of chloride of zinc or pure carbolic acid, irrigated with a solution of corrosive sublimate, dried, and dusted with iodoform. If the skin is not much implicated, the edges of the sinus should be removed, and the wound may then be sewn up, a drainage tube being inserted ; but if the skin is thinned, blue, and undermined, it should be cut away with scissors and an open wound left. For this subsequent skin grafting may be required. The head and neck must be kept absolutely quiet during the process of healing. To insure this it is sometimes desirable to fix the head by a plaster of Paris 'corona.' This consists of a long strip of Bavarian flannel of double thickness, about three inches in width, which, after being soaked in a solution of the plaster, is applied by its centre to the forehead, carried round the head, one end on either side,

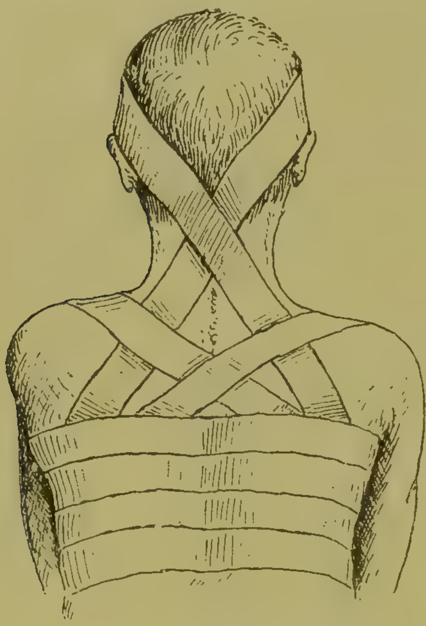
FIG. 119.—Corona bandage of plaster of Paris.

crossed behind the neck and carried down the back, gradually diverging to embrace the lateral aspects of the chest; here the ends are fixed by a rib-roller (fig. 119).

Syphilitic lymphadenitis.—In syphilis the lymphatic glands become enlarged, hard, and prominent (see page 187). This is due to an inflammatory condition, attended by a plastic effusion into the gland tissue. They rarely suppurate, but remain hard and isolated, and feel like bullets under the skin. Under the influence of mercury they disappear.

Non-inflammatory enlargement of glands.—The glands vary much in size in different individuals, and in children are proportionally larger than in the adult, so that they are often to be felt in some situations beneath the skin, e.g. the groin; the condition being one quite consistent with perfect health. In addition to this the glands occasionally undergo a painless hypertrophy, and two forms of this are commonly described: lymphoma and lymphadenoma.

Lymphoma.—When a gland enlarges without any visible cause and unaccompanied by any inflammatory symptoms, the condition is termed lymphoma. The lump is smooth and round or oval; firm but elastic; quite painless and not tender. It is movable, and does not contract adhesions to surrounding parts. Usually a single gland will be found, it may be in the neck, the groin or the axilla, but occasionally there are two or three. It does not in any way affect the patient's health, and is a purely local affection. It is composed of an increased growth of the lymphoid cells of the lymphoid tissue, which are in such abundance as to obscure the trabecular network of the gland, and in some cases the trabecular structure becomes entirely lost. The gland often disappears under treatment by change of air to the seaside and the internal administration of arsenic. If it causes any distress to the patient it may be removed, and shows no tendency to return.

Lymphadenoma (*Hodgkin's disease*) is a more extensive development of the same condition, but of far graver import. Certain glands slowly and painlessly enlarge without apparent cause and without any signs of inflammation. The enlargement takes place in one gland after another until the whole of a chain of glands may become enlarged. The same thing then takes place in another group of glands, until at last all the superficial glands become involved. And not only do we get this progressive enlargement of the lymphatic glands, but the whole of the lymphoid tissue throughout the body becomes similarly implicated, disseminated lymphoid tumours being found in the spleen, liver, kidneys, and the medulla of bone, as well as in other parts. The enlargement affects usually the cervical glands in the first instance, then subsequently the axillary, the inguinal, and others. The cause of the disease is entirely unknown. The tumours formed consist of large, smooth, bossy masses made up of clusters of enlarged glands, which do not contract adhesions to each other, and show no tendency to break down. The disease is most common in the young adult, and occurs more frequently in the male than in the female.

In some cases it is associated with a condition known as *leucocythæmia*, or *leukæmia*, in which there is a great excess of white corpuscles in the blood. It is then known as *leukæmic lymphadenoma*, and in these cases the lymphoid tissue of the spleen is early and considerably involved. As the tumours appear and increase, there is marked deterioration of the patient's health. He becomes anæmic and emaciates and loses his strength.

His appetite becomes capricious and fails. Later on diarrhœa sets in, he becomes anasarcous, and generally dies from exhaustion within about two years from the onset of the disease. On section the tumours are greyish white in appearance and vary in consistence according to the amount of fibrous stroma which exists. They often present stainings from hæmorrhage, and yield on squeezing a milky juice. Upon microscopic examination they present the same appearance as was seen in lymphoma, ordinary lymphoid tissue, with an excess of lymph cells, which resemble the white corpuscles of the blood. The excess of cells sometimes obscures the fibrous stroma of the gland tissue, and sometimes the stroma disappears, and under these circumstances the tumour presents a soft and brain-like consistence.

Treatment.—The treatment of this affection is most unsatisfactory. Operative measures appear to be of no avail. Considering the fatal nature of this disease, it may possibly be worth while to remove the enlarged glands, when the disease is seen in quite its early stage, and is absolutely confined to a single group of glands, but the results of operation are by no means encouraging. Arsenic administered in large doses and for a considerable time appears to have the greatest influence over the disease, but unfortunately this influence is only a transitory one. Under the administration of arsenic lymphadenomatous glands will often be found to diminish rapidly, and this diminution may go on until the glands have almost regained their normal size ; but sooner or later the process of shrinking will cease, the arsenic will no longer produce any result, and the glands will again begin to increase and the patient will finally succumb. Combined with the administration of the arsenic, it is desirable to send the patient to the seaside and improve his general health by tonics &c. as far as possible. Recently in two patients I have found that the administration of thyroid extract produced a very considerable diminution in the size of the glands. The cases are too recent at present to enable one to say whether this improvement will be permanent.

Lympho-sarcoma has already been alluded to in the chapter on tumours. When it occurs in the lymphatic glands, it is really a primary sarcoma of these structures. It is of a malignant character, and must not be mistaken for simple enlargement of the glands or for Hodgkin's disease. It is to be distinguished from them by its rapid growth, and by its tendency to invade neighbouring parts and to become fixed. Later on it bursts through the skin and fungates. If recognised early an attempt should be made to excise the glands, but the case is generally hopeless from the first.

Elephantiasis Arabum.—This disease is endemic in tropical climates, and is characterised by a remarkable enlargement and induration of the skin and subcutaneous tissues. It principally affects the lower extremity, when it is known under the name of *Barbadoes leg* ; the scrotum, when it is known as *lymph scrotum* ; or the labia in the female. It may, however, occur rarely in other parts of the body, as the face, the breast, or the upper extremity.

Pathology.—The disease results from obstruction to the return of lymph from the affected area, and the generally received opinion is that this obstruction is due to the presence in the lymphatic vessels of a small nematode worm, the filaria sanguinis hominis, which, as we have already seen, makes its habitat in the lymphatic system (page 267). This parasite, as we have pointed out, may be the cause of chyluria and lymphangiectasis as well as elephantiasis. The adult animal exists in some part of the lymphatic system, but the embryos are set free in the lymph and enter the blood stream, but according to Manson are found there only at night. Elephantiasis begins with attacks of lymphangitis, accompanied by fever (elephantoid fever), and each attack is followed by increased enlargement of the part affected.

In **Barbadoes leg** (fig. 120) the disease is generally confined to the tissues below the knee, but sometimes the whole limb may be affected. The limb swells enormously, principally from hypertrophy of the subcutaneous tissue and skin, and is thrown into huge folds, with deep sulci between them. The skin becomes hard and thick, and presents a coarse warty appearance. Sometimes it cracks and ulcerates. The disease is almost confined to the superficial structures, but the blood-vessels supplying the part are enlarged, as are also the lymphatic channels. The muscles are usually wasted, pale, and fatty.

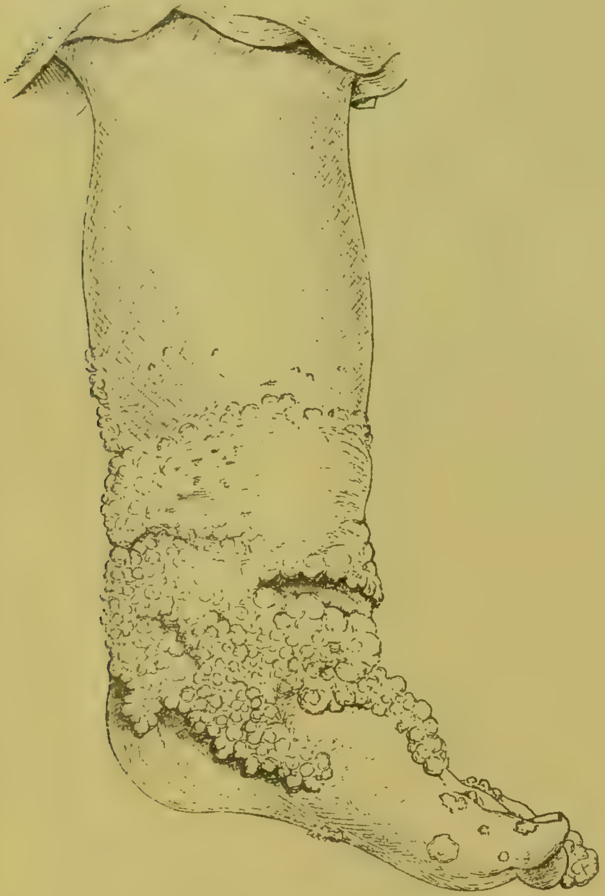

FIG. 120.—Barbadoes leg. (From a drawing in the Museum of St. George's Hospital.)

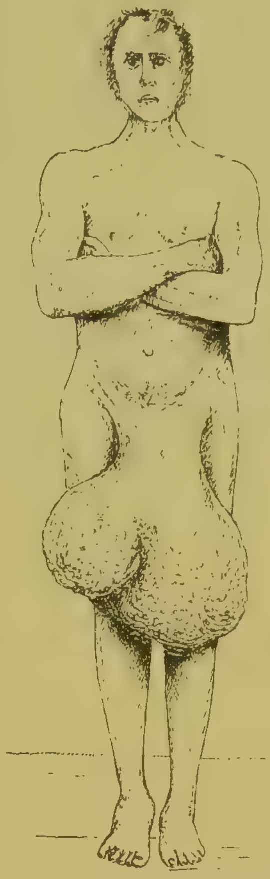

FIG. 121.—Elephantiasis scroti. (From a drawing in the Museum of St. George's Hospital.)

Lymph scrotum (*elephantiasis scroti*) (fig. 121) occurs in those cases where the upper chain of the inguinal glands are obstructed by the filariæ. It begins with an attack of inflammation, with fever, and this is followed by swelling of the scrotum, which becomes covered with vesicles from which fluid escapes; this may be milky or sanguinolent, and in it filariæ may be detected. The enlargement does not subside, and a second attack of inflammation is followed by a further enlargement, and so on, until the scrotum may reach an enormous size. This enlargement is further increased by the collection of fluid in the tunica vaginalis, which is a very common accompaniment of this disease. The swelling is pear-shaped, with its narrowest part above at its attachment to the pubes. The penis is usually buried and concealed, and the testicles lie at the lower and back part of the swelling. The skin is tense, coarse, and tuberculated, and often presents crusts formed by the discharge from the lymphatics and ulcers where these crusts have separated. A similar condition sometimes affects the labia of the female.

Treatment.—The treatment of elephantiasis is not very satisfactory. Considerable relief may be given by the methodical application of a Martin's bandage in cases of Barbadoes leg. The limb should be elevated, and while in this position the bandage firmly and evenly applied. This will reduce the size of the limb, but the swelling always returns when the bandage is left off. Dr. Manson practises excision of longitudinal strips of skin from the leg, in the hope that the cicatrices formed will by their contraction prevent further enlargement. In elephantiasis of the scrotum considerable success has attended the removal of the diseased scrotum; but the operation is a formidable one on account of the hæmorrhage. The scrotum is first to be elevated for an hour, in order to drain away as much fluid as possible, and then its neck is to be encircled with an elastic cord or clamped with Turner's clamp, consisting of two parallel bars, united by screws, so that they can be approximated to or separated from each other. Short flaps are to be cut in the skin to cover the penis and scrotum, and the whole scrotum rapidly removed, care being taken to preserve the penis and testicles.

CHAPTER III

INJURIES AND DISEASES OF NERVES

Injuries.—Nerves may be contused, compressed, or divided.

Contusion.—A nerve may be slightly squeezed, producing a sensation of pain in the part and of tingling or 'pins and needles' in its peripheral termination. A familiar illustration of this is the so-called 'funny bone' caused by a slight blow or squeeze of the ulnar nerve as it lies behind the internal condyle of the humerus. The sensation as a rule passes off in a few minutes; but when the injury is more severe and the nerve is actually bruised, that is to say, when there is extravasation of blood among its fibres, there is impairment of function of the nerve. If it is a compound one, both sensation and motion may be lost; but it is a fact of everyday experience that in these cases of contused nerve, motion is more impaired than sensation. In fact, we may have complete paralysis of the parts which the nerve supplies, with little or no loss of sensation. In this condition no immediate operation is indicated. As long as there are any indications that any sensation or motion remains, the surgeon should hold his hand and keep the parts at rest, in the hope that the normal functions may be restored. In a large majority of cases this will be so; and when a return of the sensation and motion is becoming evident, the recovery may be accelerated by galvanism and massage. If at the end of two or three months there is still loss of motion and sensation, it will be evident that the nerve has been so crushed that it cannot recover itself, and it will be right under these circumstances to consider the propriety of exposing the nerve, resecting the injured part, and suturing the two extremities. Contusion of a nerve may give rise to persistent neuralgia, or may set up a condition of chronic neuritis.

Compression.—The function of a nerve may be impaired either temporarily or permanently by pressure. This may be caused in very many ways. Perhaps the most familiar example is the pressure of a crutch on the brachial plexus in the axilla, causing 'crutch palsy.' Nerves may also be pressed upon by tumours and especially aneurisms. Thus an exostosis on the first rib has been known to cause pressure on the nerves forming the brachial plexus; a mass of malignant glands in the axilla may cause pressure on the brachial plexus; enlarged glands in the neck cause pressure on the nerves in this situation, and a pelvic abscess or stone in the bladder cause pressure on the sacral plexus or its branches. Many other examples too numerous to mention might be cited. Again, a displaced bone, either in fracture or dislocation, may press on a nerve and impair its function; or callus thrown out in the repair of a fracture may do the same thing. Finally, the contraction of scar tissue may press upon the terminal fibres of the sensory nerves and cause neuralgia and reflex spasms. The first symptoms are numbness and tingling pain, with which every one is familiar who has gone to sleep with his arm under his head. This is followed by gradually increasing anæsthesia and loss of power in the muscles, which may increase until absolute insensibility and complete paralysis ensues, and this is followed by wasting and degeneration of the muscles. In other cases pain in the course of the nerve pressed upon is the prominent symptom, and neuralgia is often due to pressure. Thus sciatica may be caused by the pressure of a pelvic abscess, or a stone in the bladder, or a loaded rectum.

Division.—Under the head of division of a nerve is included subcutaneous laceration or rupture of the nerve and section with an external wound. They never occur uncomplicated, but in many of the cases the injury to the nerve is the chief feature of the injury.

Effects of division.—Upon division of a nerve, both portions retract a little. The whole of the peripheral portion, upon being separated from its nervous centre, undergoes a rapid atrophy or degeneration. The white matter of Schwann becomes broken up and assumes the appearance of globules; the axis cylinder splits longitudinally and assumes the appearance of fibrils. Further disintegration goes on, until these structures entirely disappear, and in a few weeks the peripheral end of the nerve becomes shrunk to half its original size and consists simply of the fibrous structures, the perineurium, endoneurium, and sheath of Schwann. In the proximal end of the divided nerve the changes at first are confined to the immediate neighbourhood of the division : the nerve at this part becomes bulbous. Examined microscopically this bulbous extremity is found to consist of minute nerve fibres, which are believed to be of new formation, embedded in a mass of fibrous tissue. As time goes on, atrophic changes take place in this portion of the nerve, and it undergoes a general atrophy and shrinking, similar to what goes on in the nerves of a stump. Changes also take place in the parts to which the nerve is distributed. The muscles supplied by the divided nerve are of course at once paralysed and speedily undergo degenerative changes. Fatty granules appear in the sarcolemma, and as these appear the muscular fibres disappear, until in a few months all trace of muscular tissue is lost and the muscle becomes shrunken, pale, and fibrous in appearance. The skin to which the divided nerve is distributed becomes smooth, shining, and glossy ; it frequently becomes the seat of an eczematous eruption, and is prone to give way and ulcerate from slight injury ; the nails become striated and brittle, and the hair falls out. The joints, especially the finger joints, when the nerves of the upper extremity are divided, become inflamed ; the synovial sac distended with fluid and the capsule infiltrated with plastic effusion. This may lead to fibrous ankylosis and permanent crippling. The paralysed parts become cold and bloodless, and sometimes gangrene of the fingers or toes, in injury to one of the nerves of the extremities, ensues.

Symptoms.—When a nerve is completely cut across there is paralysis of sensation and motion when the nerve is a compound one, or paralysis of one or other when the nerve is purely sensory or motor. The loss of sensation is at once perceived, the part feels 'numb,' but there may not be complete anæsthesia on account of the connections of nerves with each other. After the division of a nerve there is at once complete paralysis of all the muscles supplied by it. Direct excitation of the muscles shows that the faradic irritability begins to diminish from the first and is very soon entirely lost; whereas the galvanic irritability produced by the continuous current is at first increased, and does not begin to diminish for some time and may not disappear altogether for months after the injury. Later on the wasting of the muscles, the smooth glazed skin, the coldness and other trophic changes, indicate the nature of the lesion.

Union of divided nerve.—If the divided ends of a nerve are placed in apposition they will readily unite and the function of the nerve will be restored. This is done in the first instance by the union of the divided ends by ordinary inflammatory exudation, which organises into scar tissue. A prolongation now takes place of the axis cylinders of the proximal end; they grow through the scar tissue, which acts as a supporting medium to them, into the lower end of the divided nerve, and over these is subsequently developed a medullary sheath. If union is effected immediately after division, before any degenerative changes have taken place, these elongated axis cylinders from the nerve above become continuous with those in the distal end of the divided nerve, and its function is restored. If union does not occur until the degenerative changes described above have been brought about, regeneration has to take place, and this is effected through the nuclei of the sheath of Schwann, which do not degenerate. These multiply, and, becoming joined, constitute new axis cylinders, which subsequently acquire a new medullary sheath. It would appear probable that almost any living animal structure can act as the supporting medium along which the axis cylinders from the proximal end can extend themselves. Thus, if the separated ends of a severed nerve are connected by a slip of connective tissue, the axis cylinders may grow downwards in this connective tissue, and thus the function of the nerve may be restored. The restoration of a divided nerve is generally slow, and a period of twelve months may elapse before it is complete; when it is, the parts gradually recover themselves. Sensation is first restored, then motion, and finally there is a return of the normal nutrition of the part.

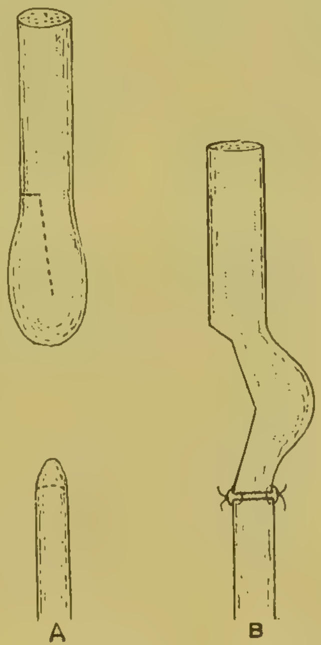

FIG. 122.—Mode of suturing a nerve by splitting the bulb. In A the dots show the line of incision; in B half the bulb is turned down and sutured to the distal end.

Treatment.—In the case of division of a nerve in an open wound, primary suture should be at once resorted to. But in cases where a nerve has been injured subcutaneously, it is better, as we have already pointed out, to wait until the surgeon is assured that actual solution of continuity has taken place. The best material for suture is fine chromicised catgut, and an ordinary round sewing needle should be used, as less likely to injure the nerve tubules than surgical needles. Two sutures are generally sufficient, passed at right angles to each other, about one-eighth of an inch from the cut surfaces, and should only be tied sufficiently tightly to bring the surfaces into apposition. After the external wound has been closed the limb should be put on a splint in such a position as to procure as complete relaxation as possible and at the same time keep the part at rest. Secondary suture may be undertaken in those cases where no attempt has been made to unite the divided nerve at the time of the injury, or where primary union has failed. It is better in these cases to render the limb bloodless by Esmarch's method, and then make an incision in the long axis of the nerve and seek for the ends above and below the place of division. Having been found, they are to be traced downwards into the scar tissue and freed from it. They are then refreshed by removing as little as possible of the ends of the nerve and suturing in the same way as in cases of recent wound. If it is impossible to approximate the divided ends without making undue tension upon them, the bulbous proximal end of the nerve can be split, as shown in figure 122, and a portion of it turned down and sutured to the lower end of the nerve. In those cases where the gap between the divided ends is still greater, or where a portion of nerve has been removed, as, for example, in removing a tumour, in which the nerve is embedded, recourse must be had to nerve grafting. A nerve from one of the lower animals which has just been killed, or from a recently amputated limb, corresponding as far as possible in size to the injured nerve, must be carefully stitched in position. This operation has now been performed on several occasions, and with sufficient success to justify its repetition.

DISEASES

Neuritis is much mixed up with neuralgia, and indeed is one of the causes of it ; but still it is a very definite affection, and requires to be considered independently of it. It may affect many nerves, and is then dependent on some abnormal condition of the blood induced by rheumatism, chronic alcoholism, diabetes, &c. ; it is then known as 'multiple neuritis,' and more properly falls under the care of the physician. As a surgical affection it is more frequently seen as affecting a single nerve or group of nerves, the result of traumatism or it may be exposure to cold. There is increased vascularity of the nerve, and in chronic cases thickening of the epineurium and perineurium, with degeneration of the nerve fibres from pressure. These changes have a tendency to spread up the nerve and implicate the spinal cord. The symptoms are intense pain and tenderness along the course of the nerve, with numbness, and tingling in its peripheral branches. Accompanying this is sometimes spasmodic contraction of the muscles supplied by the affected nerve. Later on there may be anæsthesia and paralysis.

Treatment.—The part should be kept at perfect rest and blisters applied along the course of the nerve. The administration of small doses of perchloride of mercury is often attended with much benefit. If there is any gouty or rheumatic tendency this must be treated, and sometimes it is necessary to administer opiates, the subcutaneous injection of morphia being the best form, in order to relieve the pain.

Neuralgia may be defined as pain, of an intermittent character, referred to the course of one of the sensory or mixed nerves, generally without local signs of inflammation or disease.

Causes.—Neuralgia may be caused (1) by neuritis, due to injury or exposure to cold ; (2) by irritation of a nerve trunk (page 385) ; (3) by peripheral irritation, as facial neuralgia due to a carious tooth ; and (4) by disease of the central nervous system.

Symptoms.—The pain of neuralgia is usually localised, and is situated in the course of a nerve or of several nerves. The pain is often agonising and is frequently of a darting or shooting character. It is sometimes accompanied by muscular spasm. It is an important point to remember that the pain of neuralgia, except where it depends on neuritis, is often relieved by pressure, as this forms a characteristic difference from inflammatory pain, which is increased by pressure. Neuralgia is occasionally attended with derangements in pigmentation of the skin and hair or by increased secretion of the glands. A special form of neuralgia, known by the name of *epileptiform neuralgia*, sometimes affects one or all of the branches of the fifth pair of cranial nerves. It is called epileptiform because it is often accompanied by a convulsive twitching of the facial muscles, but this is not always present. The attacks are paroxysmal, often excited by some stimulus, as a draught of cold air or a slight touch, or in fact anything which produces a stimulation of one of the branches of the fifth pair. The paroxysms of pain are generally described as beginning at one definite spot, and from this they radiate over the whole or part of the head and face, following the course of the fifth nerve or one of its main branches. During the attacks, which sometimes last only a few seconds, at others are prolonged to a minute, the face becomes suffused, the eyes water, and the patient clasps his face in his hands, with a view to relieving the pain by pressure. The length of time between the attacks varies; sometimes they recur every few seconds, at others several minutes may elapse between one attack and the next. Between the paroxysms the patient is quite free from pain. The cause of this condition is uncertain; sometimes it occurs in gouty individuals, but in most cases it does not appear to be associated with ill health. In some it appears to be due to some peripheral irritation, as a carious tooth, but in most it is apparently set up by some disease of the central nervous system.

Treatment.—In the treatment of neuralgia the first indication is to endeavour to ascertain and remove the cause. Some of these cases arise from peripheral irritation, as a carious tooth, a foreign body pressing upon and irritating a nerve, or the implication of a nerve in a scar; and the removal of the source of irritation will cure the disease. Again, other cases occur from some general conditions—anæmia due to dyspepsia and insufficient food, gout, rheumatism, debility after long-continued illness or after malarial fever or influenza; all these must be treated by appropriate remedies. When no cause can be discovered, the treatment must be empirical, and a long list of remedies might be given which have been employed for the cure of this condition, were it not that the cases fall more under the care of the physician than the surgeon. It will be sufficient to say that arsenic and quinine are the two drugs which appear to give the best results. Locally also a large number of remedies have been tried with the hope of relieving the pain: aconite, in the form of liniment; menthol; chloral and camphor; belladonna; chloroform; and the subcutaneous injection of morphia, all serve to relieve the pain for a time, but have no effect in curing the disease. Recently it has been recommended to inject osmic acid into the sheath of the affected nerve, and this is said to destroy the pain in the course of a few days. One gramme of a 1·5 per cent. solution is the quantity used for each injection. But there are always a certain number of cases in which all these remedies fail, and then will arise the question as to whether any relief can be given by surgical operation. In intractable cases, and especially in cases of epileptiform neuralgia, it is right to resort to operation, not because the nerves are the seat of the disease, nor because by this means a cure is effected in the majority of cases but because by operation rest is given to the over-stimulated nerve centres and thus relief is afforded for a time; and, so great is the distress, that the patient is willing to grasp any means of relief which may be suggested to him, even though it may be only of a temporary character.

The different operations which may be performed for the relief of neuralgia are nerve stretching, neurotomy, and neurectomy.

Nerve stretching consists in exposing the nerve by an incision, catching it up on a blunt hook and making forcible but steady traction on both proximal and distal ends. The strain which a nerve will bear without breaking varies with its size. It has been estimated that the breaking strain of the sciatic nerve is about one hundred and sixty pounds, of the nerves of the arm about half this, and the small nerves of the face about five to ten pounds. The beneficial effect of the operation of nerve stretching appears to be brought about in several ways: (1) It breaks down any adhesions which may have formed, and therefore is especially beneficial in those cases where there has been any neuritis; (2) it probably ruptures or injures the nerve tubules themselves, and so interferes with the conductivity of the nerve; (3) it tears the vessels of the sheath, and so in some way causes alteration in the vascular supply; (4) it causes degeneration of the nerve fibres and the formation in time of new ones.

Neurotomy consists in making a small puncture down to a nerve and cutting it across or in dividing it subcutaneously. This plan of treatment is, however, very unsatisfactory, as not only may the nerve be missed, but if it is divided it soon reunites and the symptoms recur.

Neurectomy consists in exposing the nerve by an incision and removing a portion, sometimes a considerable portion, of it.

Of the three operations, nerve stretching appears to give the most lasting relief. This is probably due to the fact that in nerve stretching the effect is produced not only on the trunk operated on, but also on the branches, by the traction of the distal end, and the effects are therefore more widely spread.

These operations are performed by planned incisions, which expose the nerves in certain accessible situations, in the same manner as that in which ligatures are applied to arteries.

Space will only permit us very briefly to allude to the way in which some of the principal nerves are exposed.

The **supra-orbital nerve.**—The supra-orbital notch being defined, the eyebrow is drawn up and the eyelid down, and a horizontal incision an inch and a half in length made along the supra-orbital margin, with its centre opposite the notch. The nerve is exposed, drawn up with a hook and stretched, or an inch removed.

The **infra-orbital nerve.**—Neurectomy of the infra-orbital nerve aims at removing the whole of the nerve, and preferably Meckel's ganglion with it. It may be done by an incision on the face or in the pterygo-maxillary region. The former is to be preferred on account of there being less bleeding and less risk of septic trouble. An incision is made from the outer to the inner angle of the orbit, just below the margin of this cavity, and joined in its centre by a vertical one from the angle of the mouth. The infra-orbital foramen is exposed, and the nerve defined and ligatured with a piece of silk to act as a guide. A half-inch trephine is then applied to the bone, including the foramen, and the front wall of the antrum is removed. By introducing the trephine through this opening the posterior wall of the antrum is opened and the spheno-maxillary fossa exposed. The infra-orbital canal is now opened up with fine cutting pliers, and the nerve, held on the stretch by the piece of silk attached to it, is brought into the posterior trephine hole and is severed close to the foramen rotundum by a pair of long curved scissors. Plugging will arrest the rather free hæmorrhage which takes place.

The **inferior dental nerve.**—A portion of the inferior dental nerve may be removed by exposing the outer surface of the ramus of the jaw, trephining the bone in order to open up the inferior dental canal, lifting the nerve out of the canal, and pulling away as much of the nerve as can be drawn out. Experience has, however, shown that the relief from this operation is so transitory that the removal of the whole nerve is now generally resorted to. An incision is made from the middle of the zygoma to the angle of the jaw, and then carried along the lower border of the body of the jaw as far as the anterior border of the masseter. The triangular flap thus made, consisting of skin and superficial fascia only, is reflected forwards. The masseter, which is now exposed, is divided horizontally down to the bone, immediately below Stenson's duct, and the ramus of the jaw cleaned with a raspatory. The sigmoid notch is now widened by cutting away the bone beneath it with a trephine and a quantity of yellow fat exposed, in which the nerve will be found. By hooking up the external pterygoid the nerve can now be traced to the base of the skull, and should be divided close to the foramen ovale, and again at its entrance into the dental canal in the inferior maxillary bone. The lingual nerve can be removed by the same operation.

The **lingual nerve.**—A portion of the lingual nerve may be removed from inside the mouth. An incision is made in the fold of mucous membrane between the jaw and the tongue, with its centre corresponding to the position of the fang of the last molar tooth. The nerve will then be readily felt if it is put on the stretch by pulling the tongue to the opposite side, and having been exposed may be raised by a blunt hook and at least an inch of it excised.

Removal of the Gasserian ganglion.—In some cases of neuralgia of the fifth pair, where all other operative measures have failed, the Gasserian ganglion has been removed in whole or in part. This has been done either by trephining the base or the side of the skull. Rose first performed this operation by trephining the skull at its base in the position of the foramen ovale. He made an incision from the outer canthus of the eye, along the zygoma to the tragus of the ear; then downwards to the angle of the jaw and along the lower border of the body as far as the facial vessels. He then divided the zygomatic arch at its anterior and posterior extremities, and turned it and the masseter downwards: he now divided the coronoid process and turned it and the temporal muscle upwards. The external pterygoid was then scraped away from its attachment, and the greater wing of the sphenoid and the external pterygoid plate exposed, and the foramen ovale brought into view. A trephine was now applied to the bone so as to include the foramen, and the skull opened. The ganglion was then defined and as far as possible removed.

A more efficient way of removing the ganglion appears to be by what is known as the Krause-Hartley method. This consists in making an omega-shaped flap with its attached border at the zygoma, of about two inches in length. The bone is exposed and removed, without injuring the dura mater or the branches of the middle meningeal artery. The temporo-sphenoidal lobe with the dura mater is then gradually lifted up from the middle fossa, until the foramen spinosum is reached, when the trunk of the middle meningeal artery will have to be dealt with. It has been the custom hitherto to ligature this vessel in two places and divide it between the two ligatures; a matter of great difficulty as the vessel enters the dura mater immediately on emerging from the foramen; and Mr. Horsley states that it is quite possible to excise the ganglion without dividing the artery. The chief difficulty which is experienced in this part of the operation is the free venous oozing, and it has been proposed to perform the operation with the patient in the sitting position. Though this is scarcely advisable on account of the anæsthetic, the head should be well raised on pillows. After the foramen spinosum has been exposed and the meningeal artery dealt with, a little further dissection will expose the foramina ovale and rotundum, with the third and second divisions of the fifth nerve passing through them. These nerves should be clearly defined and divided; and the dura mater being raised from the surface of the ganglion, this body is isolated, with a director or blunt-pointed instrument, the first division of the fifth nerve divided, and the ganglion lifted from its bed in one piece. The advantages of this operation are that there is less deformity and less risk. In Rose's operation there is always a danger of opening the Eustachian tube and getting septic infection and meningitis from the pharynx. There is also more risk of hæmorrhage—that is, hæmorrhage from the pterygoid plexus, and it may be from the internal maxillary artery. The results of the operation are not on the whole very encouraging, but Krause has had one case operated on more than five years ago without recurrence, and Horsley one of over four years.

The **brachial plexus** may be exposed in the neck by an incision above the clavicle, similar to that made for tying the third portion of the subclavian artery or in the axilla by an incision along the inner border of the coraco-brachialis muscle.

In the lower extremity the **great sciatic nerve** most frequently requires stretching. It may be exposed by making an incision from a point slightly to the inner side of the middle of a line drawn from the tuber ischii to the great trochanter, for three or four inches down the back of the thigh. The gluteus maximus is drawn upwards and the biceps inwards, and the nerve will be exposed. Or it may be exposed at a lower level by making an incision at the middle of the back of the thigh. The deep fascia is opened and the inner hamstring muscles separated from the biceps, and the nerve will come into view. The sciatic nerve may also be stretched by fully flexing the thigh on the abdomen with the knee bent and then forcibly extending the leg; the foot should also at the same time be flexed on the leg.

Histrionic spasm is a peculiar condition in which there is a constant momentary contraction or twitching of the muscles of expression. This is not accompanied by pain, but is a source of discomfort and distress to the patient. For its relief the facial nerve has been stretched. This may be done by making an incision behind the ear from the level of the external auditory meatus to that of the angle of the jaw. Upon dividing the deep fascia the parotid gland will be exposed, and must be drawn forwards to the anterior border of the sterno-mastoid, which will now be seen and must be drawn backwards. This will expose the posterior belly of the digastric muscle, and the facial nerve will be found running parallel with its upper border. It must be isolated with the point of a director for fear of injuring the internal jugular vein, and picked up with a blunt hook and stretched.

CHAPTER IV

INJURIES AND DISEASES OF MUSCLES, TENDONS, AND BURSÆ

INJURIES

Contusion of muscles is very common as the result of direct violence, and may vary much in extent, from a slight extravasation of blood into the substance of the muscle to a complete pulping of its structure. The signs of this injury are pain and tenderness at the site of the injury, the pain being greatly increased by any attempt of the patient to move the part; but passive motion does not excite the same amount of pain. Later on bruising appears on the surface of the skin.

Sprains without rupture are of very common occurrence, and are characterised by a sense of inability to use the injured muscle, and great pain upon attempting to do so. The injury is not one of great importance, as the condition is generally soon recovered from with a few days' rest, unless it occurs in a rheumatic subject, when it is liable to be followed by painful rigidity and stiffness, which may continue for some time. Atrophy of the muscle occasionally follows this injury, but under these circumstances it is probable that the nerves have been involved in the lesion.

Strains.—Muscles are liable to be strained when suddenly brought into very active use; this produces slight swelling, tenderness, and pain on putting the muscle into action. A familiar example of this is seen in the 'lawn tennis elbow,' which arises from strain of the pronator radii teres.

Treatment.—The treatment of these conditions consists in keeping the parts at rest, with relaxation of the injured muscle, and the application of cold, or lead and opium lotion. Later on, massage may be indicated to restore the function of the muscle. In the rheumatic sprains, douching, friction, and passive motion are the best means of improving the condition, combined with proper constitutional treatment. Ironing the part with a flat iron, as hot as the patient can bear it, is often very efficacious in relieving the pain and diminishing the stiffness.

Dislocation of a tendon.—By this is meant the displacement of a tendon from its normal groove or channel, without fracture or other injury. The two tendons most commonly displaced are the long tendon of the biceps from the bicipital groove, and the peroneus longus from the groove on the outer surface of the calcaneum. But cases of dislocation of other tendons have been recorded, the tibialis anticus tendon at the front of the ankle joint, the tendons running in the grooves at the back of the lower end of the radius, and the tendons of the small muscles of the back of the neck. The injury is produced by a sudden contraction of the muscle, when the limb is in a position which alters the ordinary line of action of the tendon. It is characterised by a sudden severe pain at one spot, and a feeling on the part of the patient that something has given way. This is followed by swelling and bruising, and inability to use the particular muscle involved, and therefore to execute certain movements.

Treatment.—By relaxing the muscle affected, the tendon can generally be thumbed backwards into its proper position, but there is the greatest difficulty in keeping it there, because the sheath which holds it in position is torn. It has therefore been suggested in these cases that the best plan of treatment is to cut down on the part, replace the tendon, and suture the sheath over it with fine buried sutures; but as the parts after a time seem to accommodate themselves to their new position and the pain disappears, it would scarcely seem desirable to cut down among a quantity of extravasated blood and endeavour to suture the torn edges of the sheath, an operation of considerable difficulty and doubtful efficacy.

Rupture of a muscle.—The muscles and tendons may be subcutaneously torn across from a sudden violent contraction. The accident generally occurs in middle-aged persons, who still retain the activity of youth, though their muscles have undergone to a certain extent degenerative changes. The muscle most frequently ruptured is the gastrocnemius. Generally only a few fibres give way, but the whole muscle may be torn across, or the tendo Achillis may be snapped. Other muscles are the biceps in the arm from lifting heavy weights; the rectus femoris, which is sometimes torn in the games of cricket or football, when the accident is known as 'cricket thigh;' or the quadriceps extensor cruris may be torn away from its insertion into the patella; the adductor longus is sometimes ruptured in riders, from gripping the saddle. Muscles are also torn during their spasmodic contraction in tetanus; the rectus abdominis is the muscle which most frequently suffers in this way.

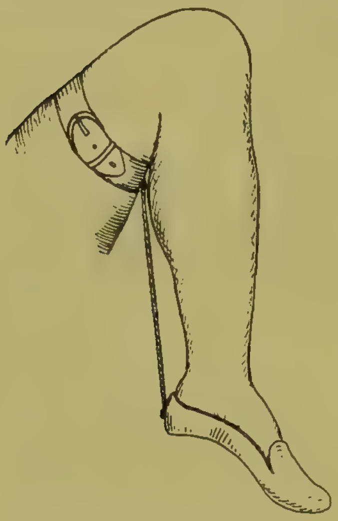

FIG. 123.—Mode of treating rupture of the tendo Achillis.

The **symptoms** are a sudden pain in the part, as if the patient had been struck a violent blow, and this is followed by inability to put the muscle into action, and in a few days by a patch of ecchymosis. If the muscle has been torn completely across, its ends retract and a hollow will be left, which can readily be felt, with a hard lump at either end produced by the contracted fibres. Extravasated blood fills up the hollow left, so that the gap is not so obvious in the early stage as it becomes later when the extravasated blood has been absorbed.

Union of the ruptured muscle takes place by fibrous tissue, and the mode of union is very similar to healing of wounds by blood clot, already described (see page 56). The blood which has been extravasated between the ruptured ends acts as a pabulum and framework. Lymph is poured out from the injured surfaces, and leucocytes penetrate into the clot and proceed to destroy it. Subsequently there is an emigration into the clot of large plasma cells derived from the connective tissue cells of the part. These in their turn destroy the leucocytes and develop into fibrous tissue. It is stated by some that striped muscular fibre is to be found in the cicatrix, but what part it takes in the process of union is by no means certain.

Union of a ruptured tendon takes place in the same way: by the emigration into the extravasated blood of leucocytes which replace the red corpuscles and fibrin; then the emigration of plasma cells, which replace the leucocytes; and, finally, the formation of fibrous tissue, some of the plasma cells forming the fibrous tissue by elongation, and others the vessels by joining end to end and forming channels.

Treatment.—The treatment of a ruptured muscle or tendon consists in placing the limb in such a position that the points of attachment of the injured muscle are approximated as much as possible, and maintaining the limb in this position. For instance, in rupture of the tendo Achillis, the limb should be placed on its outer side on the bed with the knee flexed and the ankle extended, and maintained in this position by a leather strap buckled round the lower part of the thigh and tied to the heel of a slipper (fig. 123). The subsequent stiffness and weakness must be combated by methodical friction and passive motion.

Wounds of muscles or tendons.—Muscles and tendons are frequently divided in open wounds, as in sword or sabre wounds. The diagnosis of these is usually apparent or easily arrived at, but a word or two requires to be said about the treatment. Unless the tissues are much lacerated and fouled, an attempt should always be made to suture the cut surfaces, and no pains should be spared to bring them into accurate apposition. The best material for doing this is chromic catgut, and after they have been sutured the limb should be put in such a position as to relax the muscles as far as possible. Sometimes, especially in transverse wounds in the lower part of the forearm, it is difficult to find the upper end of the divided tendon, as it has been retracted in its sheath; under these circumstances it is necessary to slit up the sheath until the tendon is exposed.

DISEASES OF MUSCLES AND TENDONS

Atrophy and degeneration of muscle.—Simple atrophy of a muscle is usually the result of long-continued disuse. The muscular fibres are wasted, but their striation still remains, while fat accumulates between them. Such a condition is recoverable from, and must not be mistaken for fatty degeneration, in which the muscular fibre actually undergoes degeneration and is converted into fat. Atrophy of muscles may also arise from lesions of the anterior cornu of the cord and of the nerves supplying them; under these circumstances the muscles undergo fatty or vitreous degeneration, in the latter case losing their striation and becoming converted into a homogeneous, glistening material.

Myositis.—Inflammation of muscles may be caused by injury; by extension from neighbouring parts; or by rheumatism. In a diffuse from it also occurs in pyæmia, and under these circumstances rapidly runs on to suppuration. The rheumatic form is said to occur in the muscles of the loin, as lumbago; in the intercostal muscles, as pleurodynia; and in the muscles of the neck, as rheumatic torticollis; but the exact pathology of these affections is unknown.

Myositis ossificans.—In this rare disease bony plates form in the substance of the muscles. The formation of bone occurs in the connective tissue between the fibres and not in the fibres themselves. These undergo atrophy. The muscles which are principally and first affected are the superficial muscles of the back, the trapezius, the latissimus dorsi, and the rhomboidei, but any other of the muscles in the body may be affected. It is more common in men than in women, and it usually commences in early life. Its cause is entirely unknown, though there are some who believe that it is rheumatic in its origin, and regard it as an inflammation of the parenchyma of the muscle.

The bony plates can be felt in the muscles, and as they increase they interfere with the movements. They usually cause no pain, merely inconvenience from the limitation of motion that they occasion, and the constrained position which the patient is obliged to assume.

The disease is slow in its progress, but as the ossification increases the movements of the thorax are interfered with, and the case terminates fatally from chest complications. No treatment is known for this condition.

In addition to these cases of myositis ossificans, ossific masses are sometimes formed in muscles, as the result of some long-continuing irritation or strain. Such a nodule is sometimes found in cavalry soldiers in the adductor longus.

Syphilitic disease of muscles.—In the tertiary stage of syphilis two forms of disease may affect the muscles. One of these is a diffuse sclerosis; the other a gumma. Diffuse sclerosis is a rare affection, and is generally met with, when it occurs, in the tongue. It is a chronic inflammation of the interstitial tissue, which at first causes swelling and enlargement of the muscle, and subsequently, when the newly formed fibrous tissue contracts, a diminution in size. The muscle then becomes hard and fixed, and its action is impaired or lost. A gumma also more frequently occurs in the tongue than elsewhere, but is not uncommon in other muscles. It grows slowly, causes pain, which is greater at night, interferes with the movements of the muscle, and eventually breaks down. It forms oval masses in the substance of the muscle, and is generally multiple. The treatment of these conditions is the ordinary treatment for tertiary syphilis.

Tumours of muscle.—Primary tumours of muscle are not common. Those most frequently met with are sarcomata, fibromata, angiomata, and cysts. Among the cysts, the parasitic cysts are perhaps the most common, viz. the hydatid, the cysticercus cellulosæ, and the trichina spiralis. Most of the innocent tumours of muscles may be treated by removal, but the malignant tumours generally require amputation when situated in the extremities. When they occur on the trunk no treatment is of much avail.

Teno-synovitis.—The synovial sheaths of tendons are liable to become inflamed, and the inflammation may be acute or chronic. Acute teno-synovitis is generally caused by prolonged use; thus the sheaths of the long tendons of the extensor muscles of the forearm may become inflamed after a hard day's rowing, or the sheaths of the long extensors of the foot and those of the peronei may become inflamed by excessive walking.

The inflammation is generally attended by a fibrinous exudation on the interior of the sheath, and when this is the case a peculiar creaking sensation is communicated to the hand placed on the part when the muscle is set in motion. Sometimes a serous effusion takes place into the sheath of the tendon, and then the creaking sensation is not felt, but there is a long sausage-shaped swelling in the course of the tendon, which is painful and tender, and the skin over it is red.

Teno-synovitis also occasionally occurs as a result of certain infective conditions—scarlet fever, gonorrhœa, and in the secondary stage of syphilis.

Treatment.—The inflammation usually subsides rapidly under the influence of rest. The part should be placed on a splint, and lead lotion and opium applied for a few days. Later on counter-irritation in the shape of blisters or mercurial ointment will promote absorption. If any impairment of movement in the tendon results from adhesions, passive movement must be employed.

Suppurative teno-synovitis has been already mentioned under the head of Whitlow (page 159). It generally arises as a secondary infection of an infective cellulitis, but may also arise from direct septic infection of the synovial sheath, or from secondary infection in pyæmia &c.

Chronic or **tuberculous teno-synovitis.**—It is now generally believed that most, if indeed not all, of the cases of chronic teno-synovitis are tuberculous in their origin. All those cases which formerly were termed *compound ganglion* have been shown, mainly through the researches of Nicaise, to be of a tuberculous nature, as well as many other cases of chronic inflammation of these structures. Two forms of the disease are usually described: one in which there is thickening of the sheath, effusion into its interior, and the formation of melon-seed bodies; the other in which there is tuberculous infiltration of the synovial sheath, which goes on to caseation. The former of these two conditions consists in a chronic effusion into the sheath of a tendon without any manifest signs of inflammation. The sheath itself is thickened, and nodules of tubercle can be demonstrated microscopically in it. From its internal surface little smooth polished bodies, resembling in shape melon seeds, hang into the interior of the sheath in a pedunculated manner, while others are found lying loose in the sheath. Tuberculous nodules may occasionally be found also in these bodies, and it has been proved experimentally that they are capable of producing tuberculosis in the lower animals. In the other condition, which has been termed the fungating form of tuberculous teno-synovitis, the disease takes on the characters of tuberculous synovitis. The sheath becomes altered and converted into a mass of granulation tissue in which tuberculous nodules may be demonstrated. This undergoes caseation, breaks down, and forms a tuberculous abscess.

Symptoms.—The first form of the disease, the so-called compound ganglion, occurs much more frequently about the sheaths of the flexor tendons at the wrist, when it is known as *compound palmar ganglion.* It may also occur in the sheaths of the tendons about the ankle joint. It forms a painless, indolent swelling, which may attain a considerable size. When it occurs in the flexor tendons of the forearm, it may form two swellings, one in the palm of the hand, and the other at the lower part of the front of the forearm, with a constriction at the anterior annular ligament, and the fluid can be forced from the one swelling to the other by pressure. When this is done an ill-defined crepitation will be felt, which is very characteristic and is due to the movements of the melon-seed bodies. The action of the muscles implicated is interfered with. In the *fungating form* there is an elongated pulpy swelling in the course of the affected sheath, which gradually softens, the skin over it become implicated and eventually gives way, and a discharge of curdy pus takes place.

Treatment.—The compound ganglion is to be treated by a free incision of the affected sheath, so as to evacuate the melon-seed bodies, which are lying loose in it, as well as the fluid. The interior is then to be thoroughly scraped so as to remove as much as possible of the diseased tissue, and it may be advisable to swab it out with chloride of zinc solution (gr. xl to ℥i). An emulsion of iodoform is then injected, the remains of the sheath sutured, the wound closed, and the part confined on a splint. In the fungating form of the disease, in the early stage, treatment by rest, combined with sea air and healthy hygienic surroundings, is to be employed. After caseation has taken place, thorough scraping and removal of the diseased tissue is necessary.

Ganglion.—The name of ganglion is given to certain cystic bodies which are developed in the neighbourhood of tendons; most commonly in those of the wrist or fingers, but also occurring on the dorsum of the foot and in some other situations. Their mode of origin is very doubtful. They were formerly supposed to be pouch-like dilatations of the sheaths of the tendons, which being constricted by the tendon became narrowed at the point of protrusion and eventually shut off from the parent sheath; but the nature of the fluid they contain, the absence of an antecedent effusion into the sheath of the tendon, and the positions they sometimes occupy, render this improbable. They have been attributed to (1) cystic transformation of the cells in the synovial fringes; (2) to the dilatation of sub-synovial crypts or follicles, which Michon has described as being found in connection with sheaths of tendons; (3) to cysts of new formation having no connection with tendon sheaths.

Symptoms.—They form hard, smooth, globular bodies, varying in size from a pea to a cherry, most commonly found on the radial side of the wrist. Though they are usually hard and simulate a solid tumour, they may be soft and fluctuating, and there is always in them a feeling of elasticity, especially if the fibrous structures around are relaxed as much as possible. Those occurring on the palmar aspect of the fingers, in the neighbourhood of the flexor tendons, are the hardest, and have been mistaken for chondromatous tumours. The ganglia in this situation never attain a large size. Ganglia are occasionally very painful from pressing upon some neighbouring nerve.

The contents of a ganglion is a clear gelatinous fluid resembling thin jelly.

Treatment.—Ganglia, when small, may often be got rid of by rupturing the sac. This can be done by tensing the skin over them and then striking them a sharp blow. Or they may be punctured subcutaneously with a grooved needle, the contents squeezed out, the interior of the sac scarified with the point of the needle, and pressure applied. Should these measures fail, the sac may be excised.

Diseases of bursæ.—The bursal synovial membranes found in the body are of two kinds: bursæ mucosæ, which are subcutaneous and are situated over prominent bony points; and bursæ synoviæ, which are interposed between muscles or tendons as they play over bony surfaces, and which frequently communicate with the synovial cavities of joints. The diseases of these two classes of bursa will have to be considered separately.

Subcutaneous bursæ.—The most common cause of disease of these bursæ is long-continued irritation from friction or pressure; but they may also become the seat of disease in syphilis, tuberculosis, and gout.

The *prepatellar* bursa is the one which is most commonly diseased, and when it becomes so is known under the name of *housemaid's knee*, as the condition is set up by the long-continued irritation of kneeling, to which housemaids are much subjected. Other bursæ commonly enlarged are the one over the acromion, from carrying heavy weights on the shoulder; the one over the olecranon, known as *miner's elbow*; the one over the tuberosity of the ischium, common in weavers and coachmen; the one over the inner condyle of the femur, caused by the use of the stretcher by carpet layers, and hence known under the name of *carpet layer's bursa*; the one over the external malleolus, which becomes enlarged in tailors from sitting cross-legged on a board, known as *tailor's bursa*; one over the posterior surface of the os calcis and tendo Achillis, from the pressure of the boot, known as the *elastic boot bursa*; and many others.

The affections to which these bursæ are liable are several.

(1) They may become acutely inflamed (*acute bursitis*), when they become suddenly swollen, hot, and very painful, and the skin over them red. The inflammation may run on to suppuration, when the redness becomes dusky, the pain becomes throbbing, and there is œdema of the subcutaneous tissues over the bursa. The temperature, which previously was probably above normal, is increased by one or two degrees. When the bursa first becomes inflamed, the patient should be confined to bed and the part kept absolutely at rest. Warm Goulard lotion with opium, or belladonna and glycerine with hot fomentations, should be applied, and the inflammation will probably subside in a few days. If suppuration supervenes, an incision should be at once made, otherwise the pus has a tendency to burrow laterally and surround the joint. When the disease affects the prepatellar bursa, the incision should be made at the outer side, as it insures better drainage and prevents the scar being irritated by subsequent kneeling. After the abscess has been opened, its cavity should be well flushed out with a 1 in 1,000 solution of corrosive sublimate, and a drainage tube inserted.

(2) An accumulation of serous fluid may take place, constituting *dropsy of the bursa*. In this state it forms a globular, tense swelling, which is sometimes translucent and fluctuates, but there is no heat or redness of the skin. The treatment of this condition is simple; if the swelling has taken place rapidly, the application of a blister will generally effect the absorption of the fluid, but there is always a tendency for it to recur. If the swelling has taken place more slowly, the fluid may be withdrawn by means of an aspirator, the interior of the sac scarified with the needle, and pressure applied by means of a pad and bandage. Or an incision may be made into the sac and a gauze drain inserted. If this is done with antiseptic precautions no suppuration will ensue, and the gauze may be removed at the end of a week or ten days. If these methods fail, excision of the sac yields the most satisfactory results.

(3) An accumulation of fluid may take place in the sac, but combined with this is the presence of melon-seed bodies. These melon-seed bodies are similar to those found in the compound ganglia (see page 397), but there does not seem to be the same amount of evidence to show that they are always tuberculous in their nature, though it is probable that many of them are so. Their presence may be ascertained by the crackling sensation that they give to the hand when the tumour is manipulated. The treatment of this condition is to make a free incision into the bursa, evacuate the loose bodies, and either insert a drainage tube or stuff with antiseptic gauze for a few days, so as to allow the sac to fill up from the bottom.

(4) The bursa may be converted into a solid or almost solid tumour. This takes place from a fibroid thickening of the wall of the sac, which

thus gradually increases in size; the cavity of the bursa remaining as a slit in the centre of the thickened walls. In this condition the circumscribed swelling is hard and solid, firm and non-elastic. It is not usually painful, but causes considerable inconvenience. The only treatment is to dissect it out.

Tuberculous bursitis.—Tuberculous disease may affect bursæ much in the same way that it affects the sheaths of tendons: either in the form of a thickening of its walls, with an effusion and the presence of melon-seed bodies; or as a tuberculous infiltration of its walls going on to caseation and eventually to the formation of chronic abscess. The treatment of this condition is removal of the bursa; or if this cannot be done, in freely laying open the cavity and scraping away all the tuberculous material.

Syphilitic bursitis.—Occasionally effusion occurs in the secondary stage of syphilis in the subcutaneous bursæ. It is generally symmetrical. The most common syphilitic change is, however, in the tertiary stage, when gummatous tumours form in their walls. They soften, involve and destroy the skin, and give exit to yellow sloughs.

Gouty bursitis.—Deposits of urate of soda occasionally take place in the walls of bursæ, especially in that over the olecranon. This may excite suppuration, and a discharge of pus mixed with chalky material takes place.

Bursæ synoviæ.—The bursæ synoviæ from a pathological point of view are of two kinds: those which communicate with the interior of a joint, and those which do not. With regard to those which are not connected with joints, little requires to be said, as in their pathological changes they are identical with those of the subcutaneous bursæ. One or two of especial importance may be alluded to. The bursa beneath the ligamentum patellæ, between it and the head of the tibia, is sometimes enlarged. This gives rise to pain, often very great from its becoming nipped between the articular surfaces of the knee joint when the leg is extended, and inability to completely straighten the leg. The bursa beneath the tendo Achillis may become enlarged and cause a swelling on either side of the tendon and materially interfere with walking. There are also three bursæ in relation with the hyoid bone and thyroid cartilage, which are sometimes enlarged and require mention:

(1. The one most frequently enlarged is the *infra-hyoid*, which lies over the thyro-hyoid membrane, between the upper border of the thyroid cartilage and the attachment of the membrane to the hyoid bone; (2) another, the *supra-hyoid*, which lies between the genio-hyoid and the genio-hyo-glossus muscle; (3) and a third, the *ante-hyoid*, which lies in front of the pomum Adami.

Bursæ which are connected with joints.—When these bursæ become enlarged, the enlargement is not due to any external irritation, but to an increase of fluid in the joint, which finds its way into and distends the sac; as a consequence of this the bursæ do not undergo the same thickening of their coats which is found in the subcutaneous bursæ subjected to irritation. They are merely dilated sacs. The bursæ in the ham are most frequently the seat of this condition, and especially the bursa under the semi-membranosus tendon. But other bursæ are also occasionally met with under the same conditions: for example, the subdeltoid bursa, beneath the deltoid muscle; the bursa beneath the psoas tendon, &c. Taking the bursa under the semi-membranosus as a type, we have, when enlarged, a tense, rounded, well-defined swelling in the lower part of the ham on extension of the leg; but when the limb is flexed the tumour becomes smaller, softer, and may altogether disappear, mainly owing to some of the fluid which it contains having passed back into the joint. These swellings occasionally pulsate, the pulsation being transmitted from the popliteal artery; but the pulsation is not of a distensile character, and no change takes place in bulk when the femoral artery is compressed.

Treatment.—In some of these cases a cure may be effected by blistering, followed by pressure, especially if the cyst is not very tense, but in many cases it gives only temporary relief and fails to cure. Under these circumstances aspiration or tapping, with injection of tincture of iodine or Morton's fluid, may be tried, but the operation is not devoid of risk and may fail, and in persons who lead an active life, and in whom the presence of the bursa causes pain and a feeling of insecurity about the joint, the better plan of treatment would appear to be excision of the tumour, which entails less risk to the patient than tapping and injection, and in which the probabilities of cure are very much greater. The operation must be performed with the most careful antiseptic precautions. An incision is made over the swelling, and the cyst well exposed. It is at once recognised by its clear translucent appearance; before being opened, it is separated from surrounding parts by a director as far as possible, and when this has been done, it is punctured and its contained fluid allowed to escape. When collapsed, it is to be seized with a pair of catch forceps, and pulled out of the wound, any further connections being torn through with the director. When the whole of the cyst has been delivered, and the neck, which will be found dipping down between the tendons, exposed, a number of fine chromic catgut sutures are to be passed through the neck of the sac (fig. 124), and when this is done the sac removed by cutting through the neck just beyond the sutures. The sutures are then rapidly tied, and the external wound closed, the sutures in the sac being left buried.

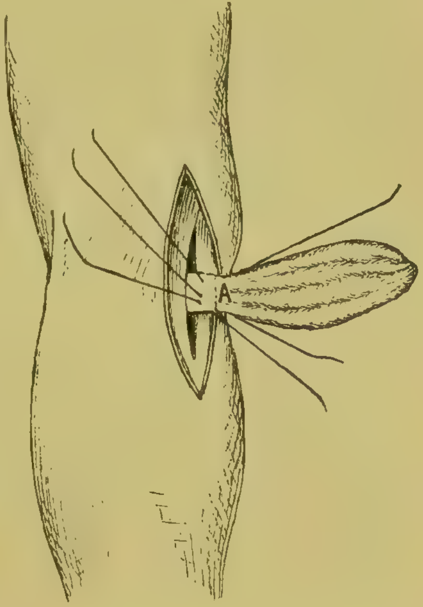

FIG. 124.—Diagram to show the method of removing an enlarged bursa beneath the semi-membranosus tendon. The dotted line A represents the site at which the bursa is to be removed, after which the sutures are tied.

Bunion is the name given to an enlarged bursa, over the head of the first metatarsal bone in cases of hallux valgus. This condition will be described in the chapter on deformities.

Diseases of fasciæ.—The hand is sometimes the seat of a very inconvenient deformity which arises from a contraction of the palmar fascia and is usually known by the name of *Dupuytren's contraction.* It is rarely met with before the age of forty, and occurs almost exclusively in men. It consists in a contraction of the fascia and of prolongations from it to the sheaths of the flexor tendons, the tendons themselves not being affected. The skin, which at first is not implicated, becomes after a time adherent to these fascial prolongations. The disease would appear to be inflammatory in its nature, and to consist in the formation of scar tissue, which after its formation undergoes contraction, and so produces the deformity. It is probably in most cases gouty in its nature; though it is sometimes said to be hereditary. Possibly it may be that the gouty diathesis has been inherited. As an exciting factor in the production of the disease, there may be some direct irritation of the palm, as in those trades where some instrument is worked by constant pressure with the palm of the hand, and the pressure of the hand on a stick in walking.

Symptoms.—The disease begins with the formation of some induration in the palm, generally at the ulnar extremity of the principal transverse crease. This is followed by some flexing of the little finger, which cannot be completely extended; the induration spreads, and the ring finger becomes drawn down. The disease may be confined to the ulnar side of the palm, and these two fingers may be alone implicated, or it may spread to the other fingers, and in rare instances to the thumb. As the disease progresses the fingers become firmly flexed on the palm, and cannot be extended by any effort. On examination, tense ridges will be felt extending from the palm to the contracted fingers. The flexion is confined to the first and second joints, the third phalanx remaining extended. The disease must not be mistaken for contraction of the flexor tendons. This condition is generally the result of some injury, of which there will probably be the history, and on attempting to straighten the finger the tendon at the wrist will be felt to become tense. The disease is not usually attended with any pain, but seriously cripples the hand and may eventually render it practically useless.

Treatment.—In the early stages manipulation and massage, combined with a suitable instrument, to be worn at night, will generally prevent the extension of the disease, but the patient should be cautioned that the abandonment of these measures will be followed by a return of the contraction. Any gouty condition should at the same time be treated. Later on the only treatment is by operation. Many different procedures have been adopted, but the plan advocated by Adams appears to yield the most satisfactory results. It consists in subcutaneously dividing the indurated bands, wherever they can be felt to be tense, with a very fine tenotome. Adams recommends about four punctures for each finger, but it is better to divide every band which can be felt until the finger can be completely straightened. After this has been done, the hand must be put on a splint with the fingers extended. When the wounds are healed, passive movements must be employed for some time. The open method consists in making a longitudinal incision and dissecting away the thickened bands. This is a more radical operation, but of much greater severity.

CHAPTER V

INJURIES AND DISEASES OF BONE

INJURIES

Contusions.—A direct blow on a bone may give rise to bruising of the bone and periosteum, and this may be followed by inflammation, especially in tuberculous, syphilitic, and gouty subjects. But, as a rule, the inflammation quickly subsides and no evil results follow. It may be, however, that pathogenic organisms find their way to the injured tissues, and then serious results may be set up. In tuberculous subjects the tubercle bacillus may reach the part and tuberculous osteitis supervene; in other cases pyogenic organisms may be introduced, and acute suppuration follow. In old people a bruise is sometimes followed by atrophy of the bone, and consequent shortening.

The **treatment** in these cases consists in keeping the part absolutely at rest and applying warm fomentations; of which perhaps warm Goulard and opium lotion is the best. If any periosteal thickening and pain remain after the acuter symptoms have subsided, the internal administration of iodide of potassium and counter-irritation locally are indicated.

Bending of bones.—Bones may sometimes be bent in the very young, as the result of injury, without any structural disease. But in the adult it can hardly occur except in cases where some change has taken place in the bone which diminishes its firmness. Even in young children bending of bone is usually associated with a partial solution of continuity, constituting that form of injury which is known under the name of *greenstick fracture*, and the two conditions can scarcely be distinguished from each other. Bending is, however, believed sometimes to occur in the skulls of young children without the rupture of any of the bony fibres.

Greenstick fracture.—By the term greenstick fracture is meant a fracture in which there is only a partial separation of the fibres of a bone, the rest remaining unbroken. The same thing occurs in these cases as when a green bough or branch is snapped across the knee. The fibres on the convex surface of the bend give way, and then if any more force is applied, the bough splits longitudinally, and the fibres on the concave surface remain unbroken (fig. 125). These fractures almost always occur in children, when the bones contain a larger percentage of animal matter, and principally in the clavicle and the bones of the forearm.

Treatment.—When a bone is bent or a greenstick fracture has taken place, a little force will generally remedy the deformity; after which the limb should be kept on a splint, or some fixed apparatus should be applied to prevent its recurrence.

Fractures.—A fracture may be defined as a solution of continuity of bone, produced by violence.

Etiology.—Fractures are always the result of force applied to the bone, but the amount of force applied may vary very much, since certain predisposing causes render fracture more liable to occur in one case than another. The local or determining causes of fracture are three. (1) *Direct violence*, where the bone gives way at the point struck. These fractures are the worst with which the surgeon has to deal, as the bone is usually crushed or broken up into small pieces, and the soft parts over the fracture are often much contused and torn. (2) *Indirect violence*, where the bone gives way at some other point than that to which the force has been applied. The accident is usually produced by the compression of the bone between two opposing forces, as in a fall on the point of the shoulder, when the clavicle is compressed between the weight of the body and the resistance of the ground, and first bends at its weakest point and then breaks. These fractures are therefore usually oblique. (3) *Muscular action*. This is not so frequent a cause as external violence, and fractures produced in this way are caused by traction and not by compression. Sometimes bones may be broken across in this way, as the patella from the contraction of the quadriceps extensor; the olecranon from contraction of the triceps; and the humerus from violent muscular action in throwing a cricket ball or a stone; in other cases bony processes into which powerful muscles are inserted may be torn off by their action.

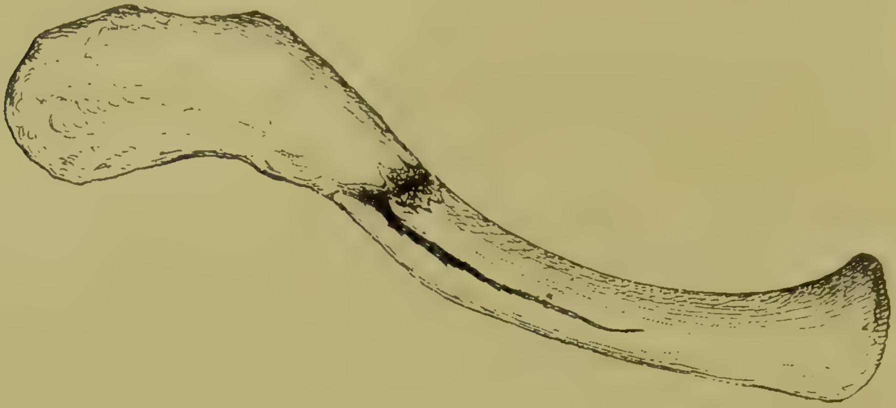

FIG. 125.—Greenstick fracture of the clavicle.
(From a preparation in the Museum of St. George's Hospital.)

Predisposing causes of fracture.—The age of the individual has a very decided influence in determining fracture. Bones being elastic and containing more animal matter during early life, are less readily broken than when they have become brittle, from containing more earthy material, in advancing years. Accordingly we find that after the age of five, in males, the liability to fracture steadily increases up to middle life. Before the age of five the greatest number of fractures occur just about the time the child is beginning to run about alone and is still unsteady on his legs: hence he is subjected to frequent falls, which may result in fracture. Sex is also a determining influence in fracture, these injuries being much more common in the male than in the female up to the age of forty-five. This is what is naturally to be expected on account of the former being exposed to more risk of injury than the latter. After forty-five, in consequence of the frequency of fracture of the neck of the thigh bone and of the lower end of the radius in women, the proportion between the two sexes is reversed; fracture in the female being more common than in the male.

The fractures which arise from a minimum degree of violence, quite insufficient under ordinary circumstances to produce a solution of continuity of the bone, are usually termed *spontaneous fractures.* They occur in those cases where the bone has been weakened or rendered brittle by disease, such as mollities ossium, sarcomatous and secondary cancerous growths, or hydatid cysts in bone, caries and necrosis, or absorption of bone by the pressure of neighbouring tumours, or from atrophy of bone from disuse or certain diseases of the central nervous system, especially general paralysis of the insane. Syphilis, tuberculosis, and scurvy have all been credited with being predisposing causes of spontaneous fracture, but there is not sufficient evidence to show that this is so.

In speaking of the causation of fracture two special forms must be alluded to, the intra-uterine and the congenital.

The *intra-uterine fracture* usually occurs during the later months of pregnancy, from some injury, a blow or a fall, on the abdomen of the mother, especially in those cases where there is a deficiency of the liquor amnii. They also occur as a consequence of syphilis, and are then very generally multiple. They may be simple or compound. They are usually accompanied by great deformity. In spite of the injury, the mother may go her full time, and the child be born with the fracture united in a distorted position, or no union may have taken place.

Congenital fractures are those produced during the act of parturition, and are usually the result of instrumental delivery. Thus the bones of the skull may be fractured by forceps, or the humerus or femur from traction.

Varieties of fracture.—The varieties of fracture have to be considered in regard to their nature and their direction.

Varieties as to their nature.—Fractures are divided principally into two great classes, between which there are important and essential differences: (1) simple, (2) compound.

1. The *simple* or *subcutaneous* fracture is one in which there is either no wound, or if there is a wound it does not communicate with the fracture, so that no air is admitted to the ends of the bone, and therefore direct infection is impossible. In this particular it corresponds to a bruise of the soft parts.

2. A *compound* fracture is when the skin or mucous membrane over the fracture is torn, and there is a communication between this external wound and the fracture, and direct infection is possible. The external wound in compound fracture may be caused in one of two ways: either from without, in direct fracture, the same cause which produces the fracture producing also the wound; or from within, in indirect fracture, the broken end of the bone perforating the skin and causing the wound. The former of these two conditions is the more serious, because there is more bruising and laceration of the soft parts, and more probability of subsequent sloughing. In addition to these a simple fracture may become secondarily compound by the separation of a slough; or may be made so by an incision, or by perforation of the skin by a fragment, from incautious movement or rough handling.

These fractures, whether simple or compound, may be complicated with other injuries, which are sometimes of more importance than the fracture itself. (1) They may be complicated with an injury to some internal organ, as the brain in fracture of the skull, the lung in fracture of the ribs, and the bladder in fracture of the pelvis; (2) they may be complicated by injury to the main blood-vessels of the part or to some large nerve, as the musculo-spiral in fracture of the humerus, or the brachial plexus in fracture of the clavicle; (3) they may be complicated by injury of some neighbouring joint, that is to say, the fracture may extend into the joint; (4) or they may be complicated by dislocation of the fractured bone.

Various names are given to different varieties of fracture according to their extent and to the nature of the separation.

(1) *Single fracture*, where a single bone is simply broken across at a single point. To this class belong the great majority of injuries of this kind.

(2) *Impacted fractures*, where a bone is fractured, and one end is driven into the other and fixed there.

(3) *Sprain fractures*, where a thin shell of bone or a prominent process is torn off in consequence of a ligament or tendon inserted into it being subjected to some severe strain. Owing to its toughness the fibrous tissue will not yield, but the portion of bone into which it is inserted is torn off.

(4) *Multiple fractures.*—Two very different conditions are comprised under the head of multiple fractures. The term is most commonly applied to those cases where two or more bones are fractured from the same injury; as where the two bones of the forearm or leg are fractured, or where several ribs are broken. But it is also applied to cases where there are two or more fractures in the same bone, but where it is not broken up into a number of small pieces. Instances where a bone is broken in two or more places, quite separate from each other, are not common, but still they sometimes do occur (figs. 126 and 127). The manner in which this accident is produced is not very clear, but it appears to be probable that it may be caused by two forces acting on the bone at the same time; the one, it may be, producing a fracture from direct violence, and the other from indirect violence.

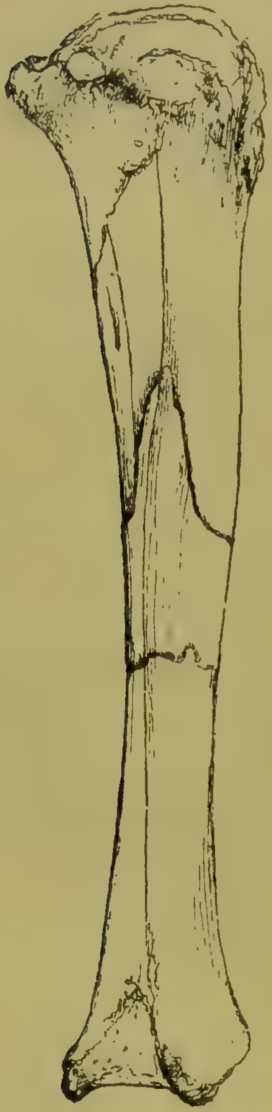
FIG. 126.—Multiple fracture of the tibia. Taken from a patient who, in attempting to get out of a train in motion, was thrown to the ground. (From the Museum of St. George's Hospital.)

(5) *Comminuted fracture.*—When the bone at the seat of injury is broken up into several small fragments it is termed a *comminuted fracture.* These fractures are usually caused by direct violence, are often compound, and attended with much contusion and laceration of the soft parts.

(6) *Incomplete fractures* are those where the solution of continuity of the bones is not complete. The greenstick fracture is the most important variety of this class; but incomplete fractures are also found in some forms of fissure of bone, especially in the bones of the skull, where there is a crack or fissure not passing completely

through the bone. To the same class belong some of the longitudinal fractures of the shafts of the long bones, where the bone is split longitudinally through a portion of its length (fig. 128). And finally some of the cases of perforated fracture are incomplete, when the perforation has not completely traversed the bone.

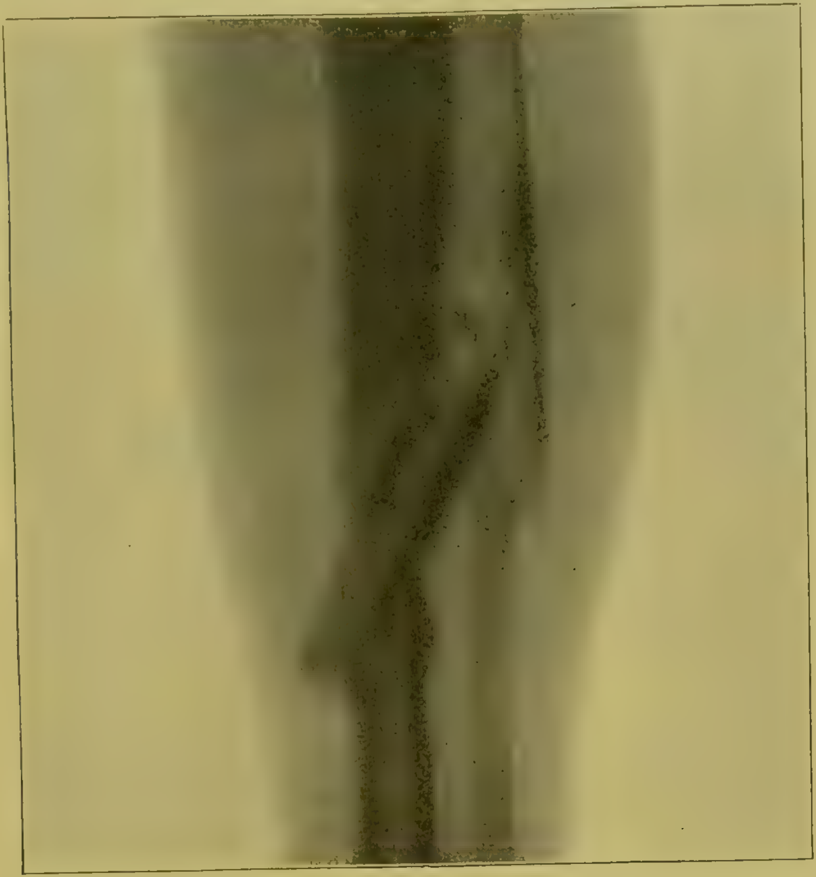

Fig. 127.—Skiagraph of a case of multiple fracture of the leg, with great displacement of the middle fragment.

(7) *Perforated* fractures are those cases where a bone has been perforated by a sharp-pointed instrument or a bullet, corresponding to a punctured wound of the soft parts. These fractures may be complete or incomplete, but are all necessarily compound.

Varieties as regards direction.—The direction which a fracture assumes is very various, and depends in a great measure upon the cause that gave rise to it. It may be transverse, oblique, longitudinal, spiral, T-shaped or stellate, names which sufficiently explain themselves. It should be remembered, however, that these forms are not always exactly defined, but that one may merge into another. Thus, a transverse fracture is not always strictly transverse, but may have a certain amount of obliquity; so that in speaking of a fracture as being transverse, oblique, and so on, we merely infer that this is the general direction of the line of fracture. *Transverse* fractures occur chiefly in children, from direct violence, generally at the ends of the long bones. There is often little displacement, and they unite readily. *Oblique* fractures occur from indirect violence.

They are more tedious in their cure than the transverse, owing to the extent of surface over which the process of repair has to be carried on. There is also usually more displacement, and more difficulty in keeping the fragments in position. They are more dangerous on account of their greater liability to be compound, owing to the sharply pointed broken end penetrating the skin. There is also a danger of the pointed end perforating a large blood-vessel or nerve. A *longitudinal* fracture is a splitting or fissuring of a long bone, and occurs especially in direct fractures, as, for example, in gunshot wounds. A *spiral* fracture is where a fissure winds round the shaft of a bone more or less obliquely. It is produced by violent twists; thus, if a person jumps from a carriage or train in motion, the moment his feet touch the ground they become to a certain extent fixed points, while the momentum of the body carries it onwards, and if this is accompanied by a twist a spiral fracture of the femur or tibia is likely to occur. A T-*shaped* fracture (fig. 129) usually occurs at the extremity of a long bone, especially the lower end of the humerus or femur, and implicates the joint. There is a transverse fracture across the bone some little distance above its articular surface, and a vertical fracture descending from this into the joint, so that the lower fragment is separated into two parts. These fractures are of importance because they are liable to be followed by impaired mobility of the joint.

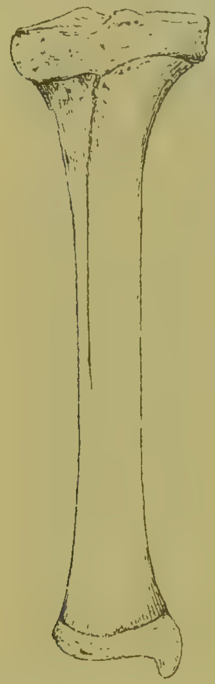

FIG. 128.—Longitudinal fracture of the tibia in a child, traversing the upper third of the shaft of the bone. (From the Museum of St. George's Hospital.)

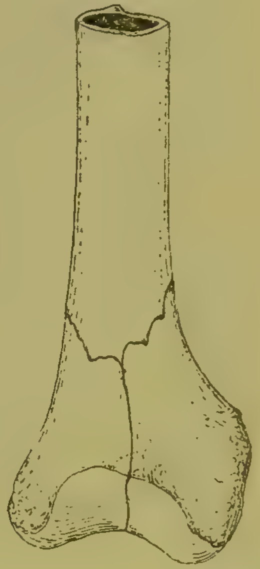

FIG. 129.—T-shaped fracture of the lower end of the femur. (From the Museum of St. George's Hospital.)

Separation of epiphyses.—No allusion has hitherto been made to another condition in which there is a solution of continuity in a bone as the result of applied violence. This is a disunion of the bone at the site of the epiphysial cartilage, and therefore occurs only in young people. The solution of continuity usually takes place through the soft spongy bone in the growing end of the diaphysis. This becomes separated from the epiphysial cartilage; but in many instances only partially so, the separation in the rest of the lesion taking place through the bone itself, a portion of it still remaining adherent to the cartilage (fig. 130). The injury generally occurs between the ages of 10 and 16, though cases have been recorded in which it has occurred up to the ages of 21 or 22, and, on the other hand, even infants have suffered from this lesion. The bones most frequently injured are the two extremities of the humerus, the lower extremity of the radius, and the lower extremity of the femur. The chief importance of the accident is that it is liable to be followed by arrest of growth in the bone, as the result of the injury which has been done to the epiphysial cartilage. In addition to this there is always a fear that the functions of the neighbouring joint may become impaired either from permanent displacement of the fragments, which it is exceedingly difficult to avoid, or from an exuberant amount of callus being thrown out, a condition which is very likely to occur in these cases.

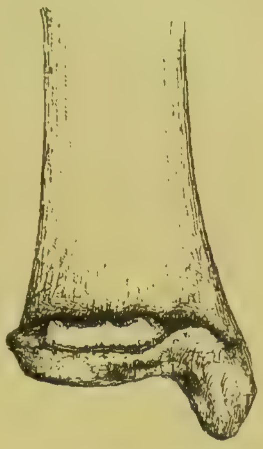

Fig. 130.—Partial fracture and partial separation of the epiphysis of the lower end of the tibia. (From the Museum of St. George's Hospital.)

Signs of fracture.—The presence of a fracture is not always easy to detect, for though there are numerous signs by which it may be recognised, and though some of these signs are pathognomonic of the injury when they exist, they are by no means always present in every case, and under these circumstances, until quite recently, it has been impossible in some instances to give a positive diagnosis. The introduction of the Röntgen rays has, however, set this difficulty on one side, and it is now possible by means of a skiagram to at once determine the existence of a fracture. In all cases of doubt, therefore, the limb should be skiagraphed. This can always be done without removing the splints, unless they are made of metal.

The ordinary signs of fracture are: (1) deformity; (2) increased mobility in the continuity of the bone; (3) crepitus; (4) impaired function; (5) ecchymosis.

In examining a case of supposed fracture the patient will usually give the history that, as the result of a sudden accident, he was conscious of something having given way, and in many cases he will further add that he heard a distinct snap at the moment. This was followed by intense pain in the part, and he found himself unable to move the limb, if the fracture is in one of the extremities. Most of these symptoms are, of course, common to many injuries, but they serve to guide us to the seat of the lesion. Upon inspecting the part there will be found in most cases further evidence of some severe injury in the presence of swelling from extravasated blood, and perhaps bruising of the skin. The degree of this swelling will depend upon the amount of laceration of the soft parts which has taken place, and the length of time which has elapsed since the occurrence of the accident; when the fracture is seen immediately after the injury the swelling may be very slight, whereas if some hours have elapsed considerable extravasation may have taken place, and the resulting swelling renders the examination of the limb more difficult.

1. The *deformity* or alteration in the shape of the limb is a most

important sign of fracture, and is in some cases almost sufficient by itself to establish the diagnosis to the practised eye. It is due to the displacement of the broken portions of bone from each other, and this displacement may occur in many different directions. Thus it may be *longitudinal*, one bone overlapping the other, and this gives rise to shortening of the limb; *angular* where the broken ends form an angle with each other and the axis of the bone is altered at the seat of fracture, so that the limb appears to be bent at this point; *rotatory* where the lower fragment is twisted on its own axis, and the limb below the fracture is seen to be rotated either outwards or inwards; and *lateral* where one fragment is displaced to one side or the other. *Separation* of the fragments may also occur in transverse fractures, and a gap may be felt between the two broken ends, as in fracture of the patella from the action of the quadriceps extensor muscle and effusion into the joint.

The principal causes of displacement of the fractured ends of a bone are four. (1) The direction of the violence. The same violence which produced the fracture may produce also the displacement, as when the bones of the skull are driven in by a blow. (2) The weight of the limb or body may drag the fractured bone out of place, as in fracture of the clavicle, where the outer fragment is drawn downwards by the weight of the arm. (3) Muscular contraction. This is the most important and the most active cause of displacement. The muscles by their contraction, which may be either spasmodic or tonic, draw the fractured ends out of their normal position, owing to the support afforded by the unbroken bone having been removed. (4) Rough handling on the part of the attendant, or the movements of the patient, especially during delirium, may cause displacement of the fragments.

2. *Increased mobility* in the continuity of a bone is a certain sign of fracture when it can be ascertained to exist; but its absence is no evidence that there is not a fracture, for in impacted fractures, in incomplete fractures, and in some forms of serrated fracture, where the ends are more or less dovetailed into each other, there is no increased mobility. And, again, in those cases where two bones lie parallel to each other, as in the forearm and leg, and one only is broken, any increased mobility is exceedingly difficult to detect and very liable to be overlooked. It is best ascertained by grasping the bone firmly above and below the supposed seat of fracture, and trying if any angular movement can be obtained.

3. *Crepitus.*—The grating of one broken end of the bone on the other is an important sign of fracture, yet there are many cases in which it either does not exist or cannot be felt: in the impacted fracture, and as a rule in the incomplete fracture, it does not exist; and, again, where the broken ends cannot be brought into apposition, either from too great separation or from overriding of the fragments, no crepitus can be elicited; and, finally, the presence of foreign bodies, as a piece of muscle or fibrous tissue, between the broken ends will prevent its being felt. In addition to this other sensations may be mistaken for crepitus, as the rubbing together of the inflamed and roughened surfaces of a synovial membrane or of a sheath of a tendon, or the grating of a rheumatoid joint.

4. The *impairment of function*, or inability to move the limb, is not a sign of any great importance, inasmuch as it is common to so many injuries.

5. *Ecchymosis.*—This sign requires special mention, since it is in some fractures the only one on which we can rely for a diagnosis. In fractures

of the posterior fossa of the base of the skull there may be no signs indicative of fracture, until the appearance of discolouration from extravasated blood some days after the accident points to the nature of the injury.

Diagnosis.—Fracture may be mistaken for dislocation on account of the deformity which is produced, but it may generally be diagnosed from it by the fact that in dislocation if the deformity is remedied it shows little inclination to return, whereas in fracture any deformity which may exist returns after reduction, when the extending force which has removed it is relaxed. Again, in dislocation there is no crepitus, unless it is complicated with fracture, and the mobility of the part is impaired rather than increased.

In impacted fractures the diagnosis is often difficult, because two of the most important signs, crepitus and increased mobility, are absent. The surgeon must be guided by the history of the case, especially as regards the direction in which the violence was applied; the situation of the lesion; and by the presence of the characteristic deformity of the particular fracture.

In incomplete fractures the diagnosis is also difficult, and in cases of fissure of bone impossible unless the fracture is compound. The presence of fixed pain, and the appearance of a linear ecchymosis some days after, would strongly point to this injury. In greenstick fractures the diagnosis is more easy, as there is the presence of deformity.

The diagnosis in cases of separation of the epiphyses is to be made by attention to the age of the patient, the position of the injury at the end of a long bone, and the nature of the crepitus, which is of a softer and less marked character than in fracture.

Union of fractures.—The union of a simple fracture is analogous to the union of a wound of the soft parts by first intention, except that the reparative process goes farther, and the scar (fibrous) tissue is eventually converted into bone. At the time of the injury the broken ends of the bone and the lacerated tissues around are surrounded by a clot of blood. A simple traumatic inflammation is set up, exudation takes place, and the clot is invaded by leucocytes, which absorb it and the damaged tissues. This is followed by an infiltration of large plasma cells, derived from proliferation of the connective tissue cells of the inflamed parts. This exudation becomes organised and converted into granulation tissue, known as *callus*, by the growing into it of vessels from surrounding tissues. The plasma cells destroy the emigrated leucocytes, and become converted into fibrous tissue, and this contracts and consolidates with obliteration of the vessels. So far the changes are identical with those of union of wounds by first intention, but now further changes take place in the callus—it calcifies and ossifies. The intercellular substance increases in quantity and the cells assume the angular form of osteoblasts, a deposit of lime salts takes place around them, and true bone is developed, in the same way as it is in ordinary ossification.

In the lower animals there is an intermediate stage of formation of cartilage, but in man this does not occur as a rule, though it is occasionally met with in the union of bones in children, and in the union of fractured ribs.

The union of bones, especially as regards the amount and situation of the callus, differs under different conditions. When there is a transverse fracture, without any displacement, and therefore the broken ends are in accurate apposition, and the limb is kept absolutely quiet so that no movement of the fragments on each other takes place, very little callus is thrown out.

There has been little injury to the soft parts around, and therefore the inflammation is confined to the bone and an inflammatory effusion is poured out between the broken ends and here alone (fig. 131, A). This undergoes the various changes enumerated above, and becomes converted into bone, and remains as the permanent bond of union. It is termed *definitive* callus. In some of these cases probably a little inflammatory effusion takes place into the medullary canal, but if so it is subsequently absorbed and the canal reopened, so that in the course of time the condition of the bone is so entirely restored that it is impossible to indicate the original site of the fracture. Secondly, in those cases where the fracture is more or less oblique, and where therefore it is impossible to maintain such accurate apposition, and where there has been a greater or less amount of displacement and corresponding injury to the soft parts, and especially where an absolute immobility of the limb is not preserved, there is inflammation not only in the ends of the bone, but in the tissues around, so that the amount of inflammatory effusion is greater, and takes place not only between the broken surfaces, but also to a considerable extent around the fractured ends, both externally, where it is called *ensheathing* callus, and also internally into the medullary canal, where it is called *internal* callus (fig. 131, B). The ensheathing and internal callus are together termed *provisional* callus, since they are only temporary and are thrown out rapidly in order to support the fracture and maintain the ends in apposition, while the definitive callus is more slowly soldering the broken ends together. The subsequent changes in the inflammatory exudation are the same, the only difference being that in the provisional callus the changes take place more rapidly,

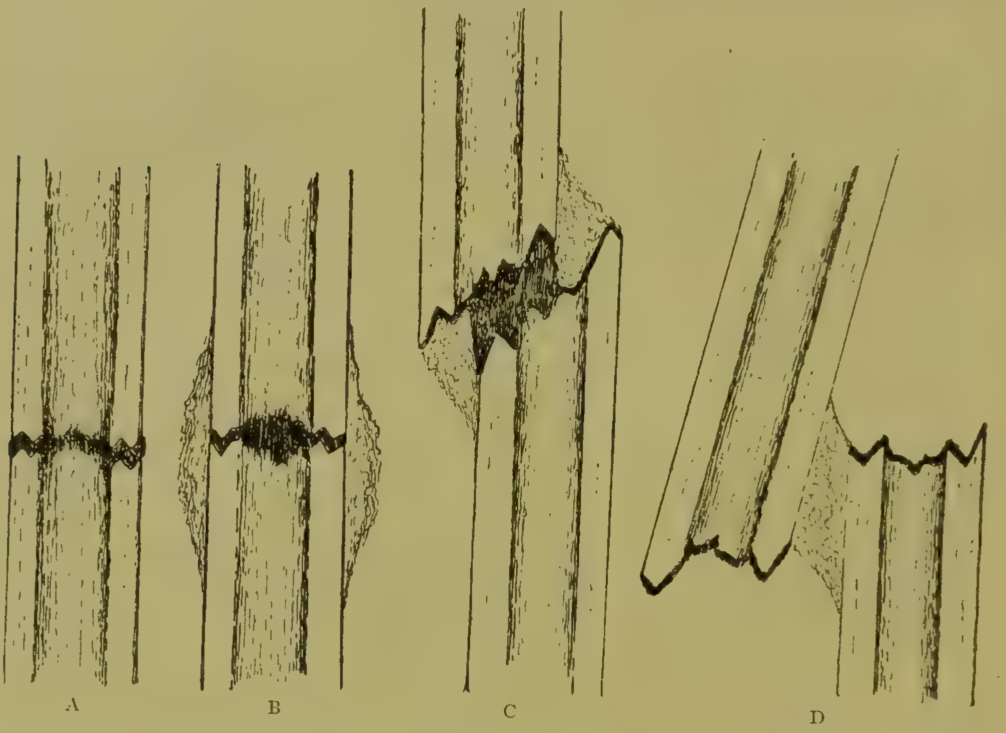

FIG. 131.—Diagram showing the different ways in which fractures unite. A, by definitive callus alone ; B, by ensheathing callus ; C, by ensheathing callus filling up the intervals between displaced bones ; D, by interposed callus.

and it becomes more quickly converted into bone. As soon as the definitive callus has become bony and has firmly welded the fractured ends together, the provisional callus begins to be absorbed, and being no longer required to maintain the parts in apposition finally disappears. This is the mode of union in bones like the clavicle and ribs, which cannot be kept perfectly immobile on account of the constant movements in respiration; and also in the lower animals, where absolute immobility is impossible.

In those cases where the reduction of the fracture has not been complete, but the ends of the bones partially overlap each other, callus is thrown out in the spaces left between the overlapping fragments; the sharp margins of the bone are rounded off, and the permanent bond of union is partly this ensheathing callus, which fills up the spaces, and partly definitive callus thrown out between the bones where they are in apposition (fig. 131, C). If there has been great displacement, which has not been reduced, and the fractured ends are not in contact at all, then callus is thrown out between the surfaces of the bone as they lie in contact or nearly in contact with each other, and they become united with great deformity. The callus is then called *interposed* callus (fig. 131, D). At the same time, in these cases a small amount of inflammatory exudation takes place at the fractured ends, and this ossifies, so that they become coated with a thin shell of bone, which closes the medullary canal. The ends of the bones also become rounded off and smoothed (fig. 132).

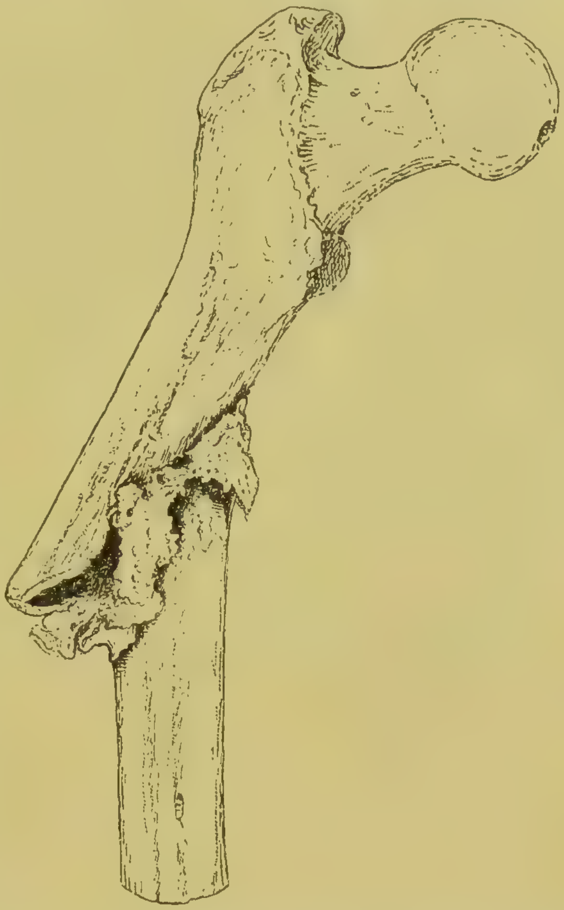

FIG. 132.—Fracture of the femur, which has united with great displacement, showing the interposed callus. (From the Museum of St. George's Hospital.)

Union of compound fractures.—The mode in which union of a compound fracture takes place depends upon whether the parts can be rendered aseptic or not. If they can, and the skin wound heals by first intention, it becomes a simple fracture and unites in the manner already described. If, however, suppuration takes place, then the bone unites by a process analogous to union by second intention in wounds. There is abundant inflammatory exudation from the injured parts. This becomes converted into granulation tissue, which fills up the wound from the bottom. The deepest part of this, derived from the bone and periosteum, contains cells which become angular and assume the form of osteoblasts, calcification takes place around them, and the tissue becomes converted into bone.

Treatment of fractures.—The treatment of a simple fracture consists first of all in bringing the broken ends of the bone into as perfect apposition as possible, and secondly in preventing any recurrence of the displacement. It will be convenient to consider the treatment under three heads: (1) The reduction of the fracture; (2) the prevention of the return of the displacement; and (3) the general or constitutional treatment of the patient.

(1) **The reduction of the fracture.**—This should be attempted as soon as possible after the receipt of the injury, for several reasons. In the first place, immediately after the accident the patient is in a condition of shock, and his muscles are relaxed and flabby, and offer no impediment to the reduction, whereas after reaction has taken place the muscles are in a state of contraction, and a greater force is therefore required to overcome their resistance. Secondly, if reduction has been delayed for a few days, the tissues around become infiltrated and matted together with inflammatory effusion, and thus reduction is prevented or a greater force has to be employed in order to effect it. Thirdly, so long as the fracture is unreduced there is always a risk of the broken ends, especially if pointed, perforating the skin, or from pressure causing sloughing, and so producing a compound fracture, or the displaced bone may irritate and lacerate muscles and nerves and so induce violent spasm. As a rule it is better to avoid the administration of an anæsthetic during the reduction, as a patient suffering from shock is not in the best possible condition to take an anæsthetic, and there is always a fear that while taking it he may by his movements cause further damage to his injured limb.

Reduction is effected usually by an assistant holding the limb above the fracture and making counter extension, while the surgeon grasps the bone below the fracture, and by making extension, combined if necessary with a slight lateral or swaying movement, he pulls the bone into its place. The manœuvre should always be attempted with opposing muscles relaxed as far as possible. Thus in the common fracture in the lower third of the leg the knee should always be flexed, in order to relax the gastrocnemius, and the assistant grasps the bones of the leg below the knee with the limb in this position. In cases where, in spite of this, reduction cannot be effected, further relaxation may be obtained by subcutaneously dividing the tendo Achillis, but this proceeding is hardly ever necessary. In making the extension the pull should be steady and continuous, not jerking; it should be made in the direction of the axis of the bone, and the fractured bone should be grasped at either extremity, by the surgeon and his assistant, without including a neighbouring joint.

(2) **The prevention of the return of the displacement.**—Reduction having been effected, means must be taken to prevent the fractured ends becoming again displaced. There are three causes which may conduce to this: first, the contraction of neighbouring muscles: secondly, the movements of the patient; and thirdly, the weight of the limb. Of these the contraction of the muscles is the most important and the most difficult to overcome. It is to be brought about by putting the limb in such a position that the muscles are in a state of relaxation, or by fixing the limb in such a manner that the muscles though contracted cannot displace the fragments.

The various means used for retaining the fractured ends of a bone in apposition are bandages and strapping, splints, and some forms of special apparatus.

Bandages and strapping are sometimes the best means available for retaining fractures in position after the deformity is reduced. Thus in fractures of the ribs, of the clavicle, and of the pelvis, this is the usual means employed. Care must be taken in applying them that they press evenly on every part, and that they are applied with sufficient tightness to support the part and restrain its movements, but not so tightly as to interfere with the circulation.

Splints.—Many materials are employed for the manufacture of splints. Probably the best material for the majority of fractures is some light wood, such as deal, though metal splints are sometimes employed, but they are cumbersome and heavy, and as a rule possess no advantages over the wooden splint. In the application of splints there are certain first principles which should always be borne in mind. (1) They should always be well padded, especially where they press upon subcutaneous portions of bone. (2) As far as possible they should be sufficiently long to include the joint above and below the seat of fracture, so as to fix the whole of the bone. (3) They should be sufficiently broad to encase the whole limb. (4) They should be so applied as not to impede the return of venous blood from the limb or arrest the supply of blood to it. (5) No bandage as a rule should be applied beneath them. (6) They should be so arranged that the seat of fracture is exposed to view, or, at all events, that neither the splint nor the bandage presses upon the fractured part. (7) The extremity of the limb should be left uncovered, so that it can be examined periodically, and any coldness or congestion, from obstruction to the circulation, at once detected.

Another form of splint which is constantly in use is one made of some material which can be moulded to the limb, such as millboard, felt, poroplastic, leather, or gutta-percha. Bandages saturated with some material such as plaster of Paris, gum, silicate of soda, or starch, are also used. Some surgeons advocate the employment of these immovable splints from the beginning of the case, others adopt the plan of applying wooden splints for a time until all swelling has subsided, and then putting the limb up in one of these kinds of fixed apparatus. The advantage claimed for the former plan of treatment is that there is more complete fixation of the fragments, and that therefore prolonged confinement to bed is unnecessary, and the patient is able to get up and go about on crutches. The objection to it is that it entirely prevents our seeing what is going on at the seat of fracture, where serious mischief may be progressing without the surgeon being aware of it. And in addition to this, if there is any swelling at the time the limb is put up, this may subside in the course of a few days and the casing become loose and faulty, and imperfect union may be the result. If, therefore, an apparatus of this sort is used, it should be fashioned in such a way that it can be removed occasionally and the limb inspected. The apparatus which best fulfils these requirements of a 'movable-immovable' splint is the plaster of Paris splint advocated by Croft. In order to describe its mode of application, we may take a fracture of the leg as an illustration. Four pieces of Bavarian flannel (a form of common house flannel) are cut into the shape of ordinary side splints, of appropriate size. Two of these are well soaked in a mixture of plaster of Paris and water of the consistence of thick cream; the other two are laid on a table and rubbed over, on one surface only, with the same solution of plaster of Paris. One of the thoroughly saturated pieces is then laid on the top of each of these, and thus two side splints are fashioned, each consisting of two thicknesses of flannel, the inner surface having no plaster on it, and being placed next the skin. The side splints are now applied to the limb and rapidly bandaged on, and thus moulded to the part while in the process of setting. When they require removal the bandage is slit up in front between the two splints and the whole removed in one piece; the bandage behind, in the interval between the splints, forming a sort of hinge. It can be reapplied and fixed on with another bandage.

Various forms of *special apparatus* are occasionally used in the treatment of fractures. These will be alluded to under the description of the special fractures for which they are employed.

The time the splints or other mechanical appliances should be kept on varies greatly, but as a broad rule it may be stated that six to eight weeks ought to be allowed to elapse in fractures of the upper extremity before the patient is allowed to go about without any support, and from eight to ten weeks in fractures of the lower extremity. After the splints are removed treatment is required to restore the normal functions of the limb, and this is often the most difficult part of the management of many cases of fracture. Stiffness and pain are often present when the splints are discontinued from matting together of the tendons and soft parts in the neighbourhood of the fracture. Under these circumstances a prolonged course of massage and passive movements is required before the integrity of the parts is re-established. Recently a modification in the treatment of fractures has been advocated, with a view to preventing this matting together of the tissues and promoting the more rapid recovery of the patient. This is done by performing massage on the patient from the commencement of the case. The plan advocated by Lucas-Championnière, who especially recommends this mode of treatment, is to discard all splints and to allow the limb to rest simply upon a soft sandbag or pillow. This, however, is not necessary nor advisable, since there is great risk of displacement taking place from some involuntary movement of the patient, perhaps during sleep. The method adopted at St. George's Hospital and introduced there by W. H. Bennett is to put the limb up in splints after reduction, and daily take them off for the application of the necessary massage, and then to readjust them. This plan of treatment has been adopted there in a very considerable number of cases, and with the most satisfactory results. The technique of the process may be best described by taking, as an example, a case of fracture of the bones of the leg, in which there is no great tendency to a recurrence of the displacement after reduction has been accomplished. After reduction the limb is placed upon a back splint with a footpiece, and fixed by a bandage around the ankle and above the knee. Gentle rubbing with the palm of the hand is then done from below upwards for about ten minutes, and afterwards side splints are applied to fix the limb in the ordinary way. This proceeding is repeated every day for a week, the time being gradually increased to twenty minutes. At the end of this period, the limb may be freed from the back splint and gently raised after the rubbing has been completed, and the ankle and knee joint flexed two or three times, the fracture being firmly grasped with the other hand, so as to prevent any movement of the fractured ends. At the end of ten or twelve days, if all goes well, the limb may be moved from the splint, and laid on a pillow at each sitting, and the rubbing may now be applied to the whole circumference of the limb and the passive movements more thoroughly carried out. In another week (twenty-one days from the commencement of the treatment) the fracture will be so far consolidated as to allow of the patient getting up and going about on crutches. The massage should be continued until firm consolidation has taken place and the bone is soundly united, which will be at a much earlier period than in cases treated without massage. In fractures of the bones of the leg the union is usually perfectly strong in five or six weeks, and quite sufficient to bear the weight of the body. I have seen patients bearing the whole weight of the body on the fractured limb at the end of four weeks; and at the end of that time there is no rigidity or fixation, the patient is able to move the muscles with as much freedom as on the uninjured side. This plan of treatment is especially valuable in fractures in the neighbourhood of or involving joints. But in these cases the treatment has to be conducted with extreme care, as it is necessary from the first to daily remove the limb from the splint in order to perform the necessary massage. In a case, for instance, of Pott's fracture, it is necessary every day to remove the leg from the back splint before massage can be applied to the injured part, but with care and caution this may be done without disturbing the position of the fragments, and there are no cases which so well repay a little extra trouble and attention on the part of the surgeon. In addition to the advantages above alluded to in the treatment of fractures by these means, namely, a more rapid union and an avoidance of the stiffness and rigidity which attends the ordinary treatment of fracture, treatment by massage is attended by other advantages. It materially relieves pain: it has been our constant experience at St. George's Hospital to find that patients suffering intense pain from the injury are at once soothed by the application of the first massage, so that it is a matter of daily experience to find them falling asleep before the first sitting is completed. Again, it at once allays muscular spasm, which is often a complication which interferes materially with the well-being of a fracture. Under the influence of massage this spasm is relieved, and this source of danger, on account of its liability to cause displacement of the fragments, removed. Two objections have been raised to this mode of treatment. One of these is that the constant movement of the limb may interfere with union. In answer to this all that can be said is that so far our experience would tend to disprove this, but a more extended trial must be made before we can be in a position to express a decided opinion either the one way or the other. The other objection carries perhaps more weight. It is that a thrombus may be lodged, in these cases, in a lacerated or injured vein, and that this thrombus may be displaced by the massage and carried into the circulation, producing pulmonary embolism. This accident would probably only occur very rarely, but the possibility of its doing so indicates that the utmost gentleness should be observed for the first ten days.

In some cases of oblique fracture it is sometimes impossible to maintain the fractured ends in apposition either by splints or extension; under these circumstances it is desirable that the fracture should be exposed by an incision through the skin and the broken ends wired or screwed together. And again, in other fractures, such as transverse fracture of the patella or olecranon, where there is great separation of the fragments and difficulty in approximating them, the same treatment may be adopted. Mr. Arbuthnot Lane has advised that this operation should be performed much more frequently than is the custom. He says: 'In any case of fracture in which the surgeon is doubtful whether he can bring and retain the fractured surfaces in accurate apposition, he should expose the fragments and insure a perfect result by the simplest mechanical means.'[1] It must be borne in mind, however, that such an operation exposes the patient to very considerable risk unless it is done with the most rigid asepticism, and it ought never to be undertaken by any one who has not a most thorough practical knowledge of aseptic surgery, and who is not in the constant habit of practising it in its entirety.

Annandale recommends the insertion of steel pins as an efficient and simple way of fixing fractured ends of bone together. The pins are to be made of strong steel and in varying lengths. Proper antiseptic precautions must be taken; and under these circumstances they create no irritation, and usually loosen and can be withdrawn in from two to four weeks after their introduction. The pins are best kept in a 1 in 6 solution of carbolic acid in glycerine.

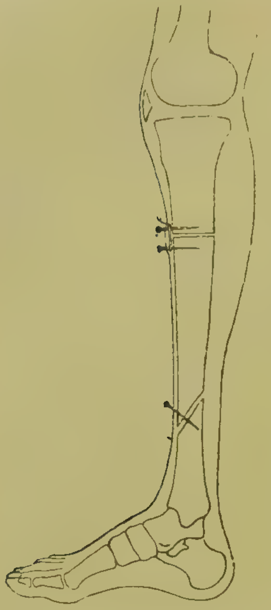

FIG. 133.—Diagram showing two methods of pinning the fractured ends of a bone together.

The illustration (fig. 133) represents the way in which Annandale uses the pins in oblique and transverse fracture. In the latter the two pins are brought together by a loop of silver wire introduced subcutaneously, the ends being twisted and brought out at the upper pin puncture.

(3) **General or constitutional treatment.**—In the treatment of fractures the habits of the patient should be interfered with as little as possible. In fractures of the lower extremity it will be necessary to confine the patient to bed until the limb is in a condition to put it up in an immovable apparatus, and the patient will be deprived of all exercise. The dietary will have therefore to be attended to, and care taken not to allow the patient to over-eat himself, and take as much food or stimulant as he is accustomed to when in active work. In consequence of the enforced quietude, the bowels are apt to become constipated, and attention must be paid to the excretions. If symptoms of dyspepsia present themselves, they must be combated by careful dieting and appropriate medicines. In old people there are two special dangers to be feared from prolonged confinement to bed; namely, hypostatic congestion of the lungs, and bedsores. Any appearance of the former is to be at once combated by raising the patient into the sitting posture, and getting him out of bed as soon as possible. Bedsores must be prevented by good nursing, scrupulous attention to cleanliness, and by relieving the pressure in the way described on page 149.

Treatment of compound fracture.—When called upon to treat a compound fracture, the first question which the surgeon has to decide is whether amputation is necessary or not. In many cases this question can be decided at a glance: where a limb is hopelessly shattered, it is clear that nothing but removal can be of any use; but there are others in which the question of removal of the limb is a very doubtful one, and a most serious and anxious one for the surgeon to decide. Certain complications are often given as indications of the necessity for amputation, such as excessive laceration of the soft parts around; extensive comminution and denudation of the bone; injury to the main vessels or nerves of the limb; and the implication of a large joint; but none of these conditions alone can be properly regarded as a necessity for amputation, and every case must be judged on its own merits, attention being given to the age and general condition of the patient; to the presence of any visceral disease, especially disease of the eliminatory organs; and to the probable service that the limb is likely to be to the patient if it is preserved.

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[1] *Clinical Journal*, vol. v. p. 397, April 17, 1895.

If it is determined to make an attempt to save the limb, the first and most important point is to render the wound aseptic, and infinite pains should be bestowed by the surgeon in order to bring this about. There should be no hesitation on his part in enlarging the wound, and freely exposing the parts. It should then be thoroughly washed out with a strong antiseptic solution (carbolic acid 1 in 20, or corrosive sublimate 1 in 1,000), and, if the tissues are engrained with dirt, well scrubbed with a nail-brush. Any loose fragments of bone should be picked out with forceps; and all bleeding vessels should be secured. The broken ends are now to be placed in position, and if there is no comminution, and especially if the fracture is oblique, should be wired together, but if there is extensive comminution this cannot be done; the fragments which are still connected by periosteum should be placed in position as far as possible. Drainage must be provided for. A good-sized drainage tube should be inserted in the most dependent part of the wound, or if necessary a counter opening must be made, and the original wound closed by sutures, unless the edges are so much bruised as to render union by first intention impossible. The wound is then dressed and put up in splints, preferably of such a nature that the wound can be redressed when required, without removing the limb from the splints.

Complications during treatment.—During the treatment of fractures various complications may arise; these may be either local or general, or there may be special complications in compound fractures. The principal local complications are: (1) œdema, (2) sloughing, (3) gangrene, and (4) spasm.

1. **Œdema and swelling** occur more or less in almost every fracture as the direct result of the injury, but soon subside if the parts are kept at rest and slightly raised, and more particularly if massage is employed. If, however, they persist, it may be from too tight bandaging, or from allowing the limb to remain in a dependent position. Occasionally the swelling is accompanied by the formation of large bullæ on the surface filled with bloody serum. In addition to this there is sometimes present a condition of solid œdema, which is most persistent, and is due to thrombosis; this, commencing in the veins in the neighbourhood of the injury, spreads from vein to vein till a considerable number of the vessels of the limb become blocked. In these cases there is some fear of a clot becoming displaced, and pulmonary embolism occurring, but happily this is very uncommon. In the treatment of œdema in the early stage nothing requires to be done but keep the parts at rest and elevated. If it arises from too tight bandaging the bandages must be loosened, and evaporating lotions applied. Bloody bullæ should be pricked, and the fluid allowed to drain away. In the solid œdema

from thrombosis, pressure from a Martin's bandage should be applied, and friction in the course of the venous circulation after the fracture has united and the clots in the veins consolidated.

2. **Sloughing** of the soft tissues over a fracture may take place, especially in fractures from direct violence, where the tissues have been much bruised and lacerated by the blow, so that their vitality has been destroyed. This converts the simple into a compound fracture. These cases of compound fracture are not nearly so serious as those where the wound is produced at the time of the injury, as by the time the fracture communicates with the external air the surfaces of the wound have become covered over with granulation tissue, and there is less risk of septic absorption.

3. **Gangrene** occasionally occurs during the treatment of fracture. This may arise from too tight bandaging, and therefore constant examination of a fracture should be made especially during the first few days, in order to note whether there is any lividity or coldness of the fingers or toes, under which circumstances the bandages should be at once loosened. Gangrene from this cause would appear to be more common in the upper than the lower extremity, and is especially apt to occur in children. Gangrene may also occur from the main artery of the limb having been injured or pressed upon by the fractured ends of the bone. And finally gangrene has been known to occur where nerves have been injured by the broken ends of the bone, or pressed upon by the callus which has subsequently formed.

4. **Spasm of the muscles** is another troublesome complication of fractures, and arises from the fragments irritating the muscles themselves or the nerves which supply them. In consequence of this there is great difficulty in keeping the bones in position, and it causes great pain to the patient. It may be overcome by massage (page 417), and patients who suffer from it will often request that the massage may be repeated on account of the relief which it affords.

General complications.—The general complications are for the most part those which follow any severe injury, such as delirium, shock, exhaustion, and to these must be added two special complications, which occur principally in the aged from the necessary confinement to bed, namely, hypostatic congestion of the lungs, and bedsores. There is one other condition, in addition to these, about which there is a certain degree of doubt. This was described by Zenker in 1862 as *fat embolism*. In a small percentage of cases, patients after fracture get a definite train of symptoms, consisting of a subnormal temperature, dyspnœa, and perhaps hæmoptysis, and in severe cases become collapsed, comatose, and die. This was attributed by Zenker to fat cells of the medulla being broken up from the injury to the bone, and the liquid fat being set free and carried by the blood stream to the lungs, where it formed emboli in the pulmonary capillaries. It is, however, very doubtful whether this is the true explanation of these cases, since it has been found experimentally that large quantities of fat can be injected into animals, causing extensive embolism, without producing any serious symptoms.

Special complications of compound fractures.—Formerly the special complications of compound fracture were of serious import, and were mainly due to septic troubles; such conditions as osteo-myelitis, pyæmia, spreading gangrene and hectic, were frequently met with in the course of the treatment of these fractures, and were the cause of the great mortality which attended them. Now, by strict attention to antiseptic principles, these conditions are very uncommon, and require no more than a passing notice. Necrosis also, which was often a frequent sequel of compound fracture (fig. 134), now only occurs occasionally, where a small portion of bone has been completely separated from the periosteum, and therefore having been cut off from its blood supply perishes from inanition.

Occasionally, it may happen that a compound fracture may become septic. It must then be treated, in accordance with the general treatment of septic wounds, by free incisions and careful drainage to prevent the retention of any infective material, and by the application of hot antiseptic fomentations, changed frequently. In cases where acute spreading gangrene shows itself high amputation must be resorted to, and probably the same treatment may be resorted to where acute tetanus, septicæmia and pyæmia are present. In more advanced conditions, when the patient becomes worn out by prolonged suppuration, secondary amputation is sometimes necessary.

Defects in the process of union of fractures.—**Delayed union.**—By the term *delayed union* is meant that condition in which the fracture does not unite as rapidly as it ought: where at the end of six or eight weeks, when under ordinary circumstances sufficient union ought to have taken place to prevent any movement at the seat of fracture, nevertheless a certain amount of yielding or movement of one fractured end or the other is perceptible. This is by no means an uncommon condition, and frequently arises from constitutional causes, of which the most common is mal-assimilation. If the urine of such a patient is examined, it will be found to be alkaline and to deposit a copious precipitate of phosphates on boiling. This is no doubt due to the fact that the patient, being confined to bed and being deprived of his customary exercise, does not assimilate his food properly. Regulation of his diet, especially confining him to fish diet, with the internal administration of the mineral acids, will generally effect a speedy union. In other cases delayed union appears to arise from constitutional debility, and tonics, change of air, &c., are indicated. Syphilis is also said to be a cause of delayed union, and if there is any evidence of a syphilitic history in such a case the proper anti-syphilitic treatment should be adopted. Finally, it appears that sometimes union of a fracture is delayed by 'meddlesome surgery': by constant readjustment of the splints, by frequent testing of the bones to see how the union is going on, a condition of unrest is kept up which naturally interferes with the proper union of the fracture.

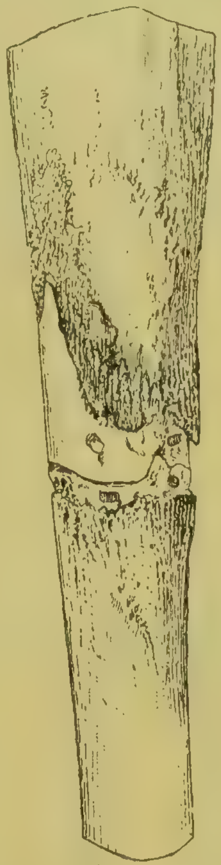

FIG. 134.—Necrosis of the broken ends of the tibia after a compound fracture. (From the Museum of St. George's Hospital.)

Imperfect union.—This condition is sometimes classed as non-union, but this it clearly is not, as union to a certain extent has taken place; the fault being that the union has not gone on to its complete condition. These are cases where the union is fibrous in its nature, where callus has been thrown out and has become converted into fibrous tissue, but the process has stopped at this point and no subsequent ossification has taken place. The most common cause of this condition would appear to be the too wide separation of the fragments from each other, as in fractures of the patella and olecranon; or defective blood supply, as in fracture of the neck of the femur.

Non-union of fractures.—It is very rare to find an entire absence of union. In most cases the broken ends will be found to be connected, to a greater or less extent, by fibrous bands passing from the one fragment to the other. So that under the head of non-union we have two conditions—one in which there is no union of any kind, and another where the ends of the bones are united by external bands of fibrous tissue, and a more or less complete condition of false joint is formed. When a false joint (*pseudarthrosis*) is formed, the ends of the bone become rounded, smoothed and polished, one end often hollowed out into a cup-shaped cavity and the other rounded and conical, so that a sort of ball-and-socket joint is formed. Between these a synovial sac or bursa may become developed, and the ends of the bone are united by a continuous investment of fibrous tissue, forming a capsular ligament. In this way the resemblance to a joint is fairly complete (fig. 135).

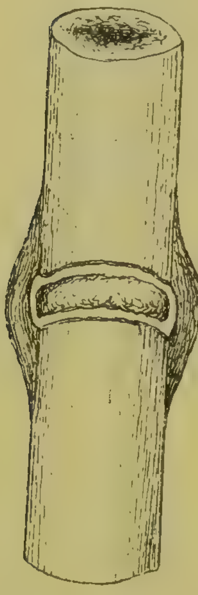
FIG. 135.—Diagram showing the changes which take place in a case of pseudarthrosis.

The causes to which this non-union have been attributed are very numerous, and have been divided into local and constitutional. Of the *local* causes there can be no question that the most common is the want of rest, and the presence of a certain degree of movement between the fragments; other causes are the presence of foreign bodies—such as muscular or fibrous structures—between the broken ends; defective blood supply to one of the broken fragments from injury of the medullary artery; and disease in the bone itself, as in osteomalacia. The *constitutional* causes to which non-union of bone has been attributed are numerous. The most potent of these is debility, arising from some general cause or from some definite disease, as syphilis or scurvy. As, however, many if not most of the cases of ununited fracture occur in individuals of robust health, it is doubtful whether these constitutional conditions, apart from some local cause, are sufficient to prevent the union of fractures.

The signs of non-union are sufficiently obvious not to require any lengthy description. They are pain, deformity, increased mobility, uselessness of the limb, and atrophy as a consequence of disuse.

Treatment.—Perhaps there is no condition for which so many plans of treatment have at different times been advocated as for ununited fracture. It is unnecessary, however, to allude to all of these, since the treatment is now fairly defined. In those cases where the fracture is comparatively recent, an attempt should be made to promote union by putting the limb up in some immovable apparatus and keeping it absolutely fixed for a period of six weeks or two months. Combined with this, means should be taken to improve the general health by change of air, careful dieting, and the administration of tonics. If the fracture is of older date, it is well to precede this treatment by placing the patient under an anæsthetic and rubbing the broken ends of the bone together for some minutes, so as to excite a certain amount of inflammation in the parts, and after this placing them in the fixed apparatus. In cases of older standing, or if this plan of treatment fails, operative measures will have to be resorted to. The fractured ends should be exposed by an incision so arranged as to reach the bone with least injury to the soft parts, and then determining the mode in which the fractured ends shall be united. If the ends are not far apart and nearly in a line with each other, they should be freshened by sawing off their extremities, if possible in an oblique direction, and then fitted together and secured by a stout silver or copper wire, which may be allowed to remain permanently, or cut down upon and removed when the fracture is united. If, however, there is considerable overlapping of the fragments, and thus the ends are widely separated from each other, and especially if the bone is deeply placed and difficult to get at, it is probably wiser to peg the bones together in their faulty position rather than to attempt to bring them into place; a proceeding which is often almost impossible without cutting away a very considerable amount of bone, on account of the shortening which has taken place in the muscular and fibrous structures. The simplest way of pegging them together is by means of a steel drill which is driven through both fragments and allowed to remain in situ with the end sticking out of the external wound until union between the bones has taken place, when it is withdrawn. It is in most instances desirable to insert two drills, and they are usually to be left in for three or four weeks or it may be longer.

Vicious union.—Union of a fracture is sometimes accompanied by considerable deformity, and this may impair movement and render the limb more or less useless. This may arise from several different causes: (1) A fracture may be badly set, either from want of care and attention on the part of the surgeon, or from his inability to overcome the deformity, or from the amount of swelling preventing him from accurately determining the position of the fragments. (2) A fracture may be properly set, and subsequently the bones may slip out of position. (3) The callus may be still soft and imperfectly ossified when the limb is taken out of the splints, and gradually yields under the weight of the body. If the displacement is angular and the deformity is discovered during the first three or four weeks after the fracture, while it is still recent, the patient should be placed under an anæsthetic and the bone forcibly straightened and, if necessary, refractured. If the deformity is longitudinal, that is to say, the one fragment overlapping the other, no justifiable force will probably be able to overcome it.

When the deformity has existed for a longer period and the bones are firmly welded together in their abnormal position, an endeavour may be made by a cutting operation to remedy the deformity, or subcutaneous refracture may be performed by means of an osteoclast. This latter mode of proceeding is advocated by some surgeons, and in cases of angular deformity has appeared to have been successful in their hands, and not to have been attended with any great amount of injury of the soft parts. But a cutting operation either by subcutaneous osteotomy or by taking a wedge-shaped piece out of the convexity of the deformity appears to be the better proceeding, because it can be carried out with more exactness and probably without any greater risk to the patient.

Disunited fractures.—Softening and absorption of callus may take place from the influence of depressing diseases, and a fractured bone which had apparently united become again disunited. The condition is a very rare one, and would appear to be more often associated with scurvy than anything else, though it has been observed in patients attacked with one of the exanthemata, shortly after the union of a fracture. The bone generally reunites under suitable treatment.

SPECIAL FRACTURES

Under the head of **special fractures** in this place we shall simply consider fractures of the bones of the two extremities. The fractures of the other bones of the skeleton will be considered in connection with the injuries of the region to which they belong, viz. the head, the face, the neck, the spine, the chest, and the pelvis.

FRACTURES OF THE UPPER EXTREMITY

Fractures of the clavicle.—The clavicle is fractured more frequently than any other bone in the body, with the exception of the radius, and the fracture is especially common in young children before the age of five. It may be broken either by direct or indirect violence, more frequently the latter, from falls upon the shoulder, the bone then giving way in an oblique direction a little external to the middle of the bone. When the fracture occurs from direct violence, it usually takes place in the outer third, as this part is more exposed to injury.

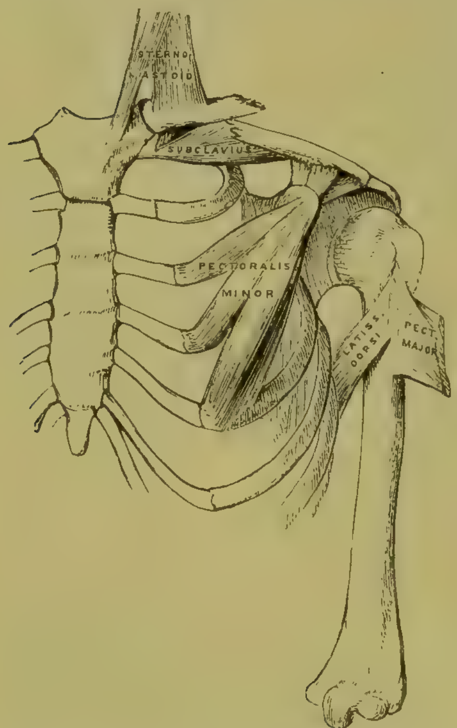

FIG. 136.—Fracture showing the displacement which occurs in the ordinary fracture of the clavicle. (From Gray's 'Anatomy.')

Fracture of the shaft.—In fracture of the shaft the bone usually gives way at its weakest part, at the junction of its curves,, a little external to the middle of the bone. It is here caused by indirect violence, and in the young is very often a greenstick fracture. When complete the fracture is oblique, running from without backwards and inwards. It is always attended with considerable displacement of the outer fragment, which is drawn downwards by the weight of the arm and inwards by the action of the pectoral muscles, especially the pectoralis minor, so that on measurement the two ends of the bone will be found to be nearer each other than on the uninjured side. In addition to this the outer fragment is rotated on an axis drawn through its centre, so that the fractured end is displaced backwards and the acromial extremity forwards. This is due to the action of the serratus magnus, which causes the scapula to rotate on the wall of the thorax, and so carries the acromion process forwards.

The **signs** of the fracture are usually very evident. The patient after an injury complains of great pain in the part, and will be noticed to support the elbow with the hand of the opposite side and bend the head towards the injured side. The shoulder will be noticed to be on a lower level and to be nearer the middle line of the body. On running the finger along the surface of the bone, a marked irregularity will be felt at the seat of the fracture. In the complete fracture crepitus can usually be detected, but it is not desirable or necessary to make any prolonged attempt to elicit it, for fear of driving one of the broken fragments into the structures beneath. In fat children, especially if the fracture is incomplete, this injury is very liable to be overlooked. If after an injury a child keeps its arm perfectly still and cries whenever it is moved, fracture of the clavicle is one of the lesions which should always be carefully sought for. In the ordinary oblique fracture from indirect violence there is hardly any complication of importance and the fracture usually unites readily, so that in three weeks the fragments are fairly consolidated to each other. In fracture from direct violence there is danger of injury to the subclavian vessels or the brachial plexus, and in some few instances the pleura has been punctured by the fractured end of the bone.

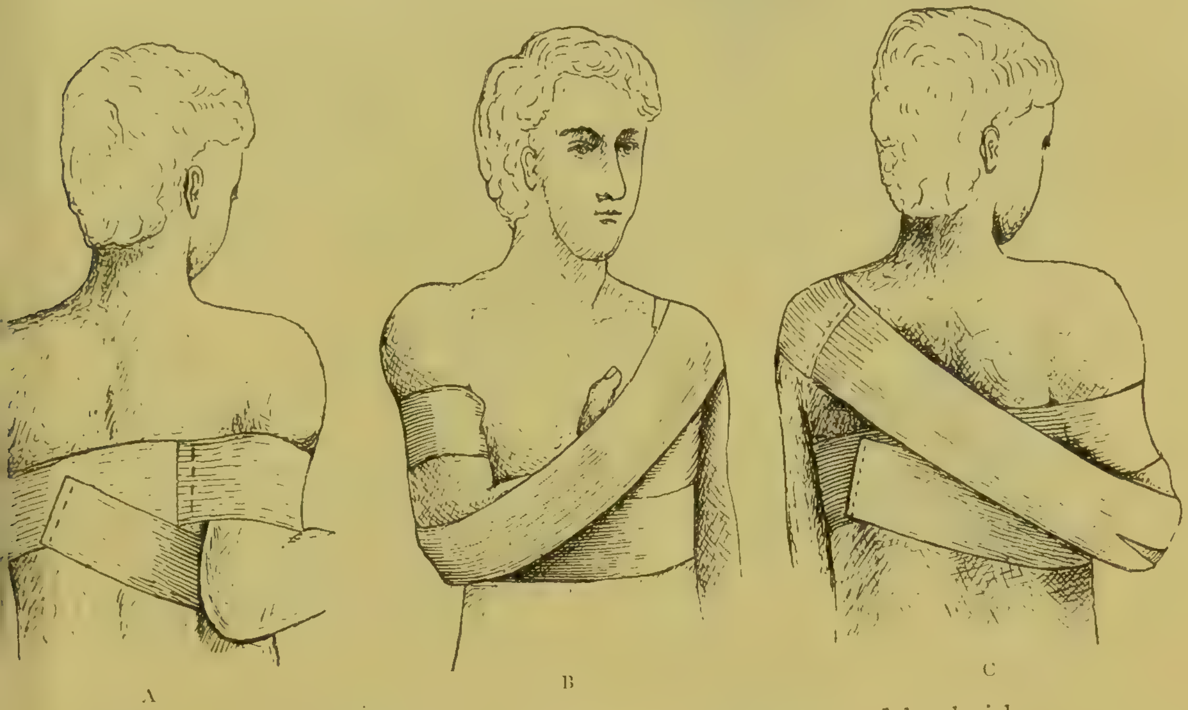

FIG. 137.—Diagram showing Sayre's method of treating fractures of the clavicle.

Treatment.—In order to replace the fragments, the surgeon should stand behind the patient and place his knee in the middle of the back between the two scapulæ, and seizing the points of the acromion processes in his two hands draw the shoulders directly backwards, when with a little manipulation the fragments will come into position. In order to retain them there the plan recommended by Sayre appears to be certainly the best. Take three strips of adhesive plaister, three and a half inches in width and sufficiently long to encircle the chest and arm. The first strip is to be sewn loosely round the arm, as close to the axilla as possible, with the non-adhesive side next the skin. The shoulder is then drawn backwards and the strapping made to encircle the chest from behind forwards, that is, round the back first and then on to the front of the chest. The adhesive side will be next the skin, and must be made to adhere to it. The end of this strip is carried under the axilla and stitched to the part which crosses the back (fig. 137, A). The elbow of the injured side is now carried well forwards, and the loop of the strip of plaister already applied acts as a fulcrum, and the upper end of the humerus with the clavicle is forced backwards. While the elbow is in this position a second strip of the plaister is applied to the sound shoulder, carried obliquely across the back to the elbow on the injured side, where a hole is cut in it to receive the point of the elbow, and it is then carried upwards on to the front of the chest and fastened to the other end over the top of the shoulder (fig. 137, B and C). This serves to keep the shoulder raised. The third strip is now placed round the chest, arm and forearm to keep the arm fixed to the wall of the chest. A special apparatus, known as *Ellis's crutch*, is sometimes used and answers very well. It consists of a crutch and two webbings. One webbing has a pocket in it, which supports the crutch and is buckled over the sound shoulder. The other webbing fixes the arm to the side. The exact arrangement will be readily understood from the accompanying diagram (fig. 138).

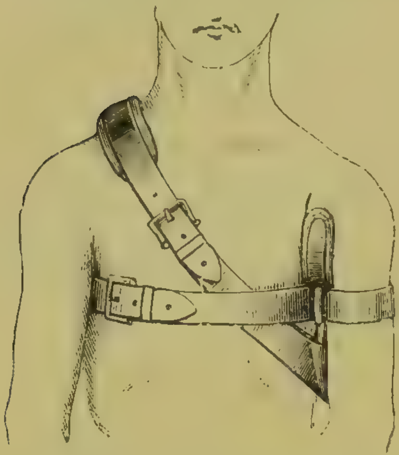

FIG. 138.—Figure showing the manner of applying Ellis's apparatus in the treatment of fracture of the clavicle. (From Pick's 'Fractures and Dislocations.')

Fracture of the acromial end of the clavicle.—Fracture of the acromial end of the clavicle is usually the result of direct violence, and may take place either between the conoid and trapezoid ligament, or external to the trapezoid ligament. In the former there is usually very little or no displacement; but the fracture may be diagnosed by the evidences of an injury in this situation, a fixed pain and crepitus. When the fracture takes place external to the ligaments there is great displacement; the outer fragment is drawn downwards by the weight of the arm and inwards by the action of muscles, so that it forms a right angle with the rest of the bone. There is no difficulty in recognising this fracture. The deformity, with crepitus, renders it evident. The **treatment** of the fracture between the ligaments simply consists in fixing the arm to the side. In the fracture external to the ligaments treatment is difficult, as it is almost impossible to retain the

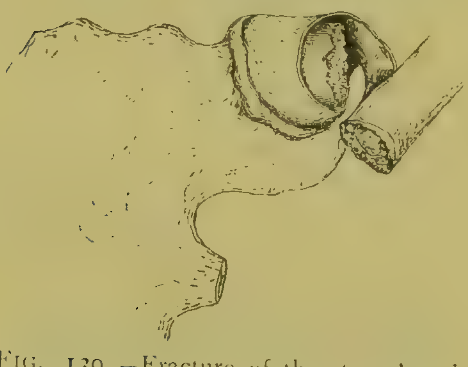

FIG. 139.—Fracture of the sternal end of the clavicle. (From the Museum of St. George's Hospital.)

small outer fragment in position, and the patient should be told that there is a probability of there being some slight deformity, which will not, however, interfere with motion. A pad should be placed in the axilla, the arm bound to the side, and a leather cap moulded to the shoulder.

Fracture of the sternal end of the clavicle (fig. 139) is very uncommon, and may be caused by either direct or indirect violence. The displacement, which is confined to the outer fragment, varies as to whether the fracture is internal or external to the rhomboid ligament. In the former it is displaced slightly forwards; in the latter downwards and inwards. The deformity which is produced is an abrupt projection at the situation of the fracture and characterises the injury. It is best treated by a figure-of-8 bandage over the points of the shoulders and crossed behind the back.

FRACTURES OF THE SCAPULA

Fractures of the scapula are not common. They may involve the body, neck, acromion or coracoid process.

Body.—Fracture through the body is almost always caused by direct violence, and the lesion is generally in the infra-spinous fossa; though in some cases the supra-spinous fossa is broken, or we may have a fissure running from the one fossa to the other across the spine (fig. 140). The bone may be simply fissured, or a stellate fracture may occur, or the bone may be extensively comminuted. The injury is often complicated with fracture of the ribs. The **signs** are great pain—especially on any attempt being made to move the bone on the wall of the chest—bruising and swelling. Crepitus may sometimes be elicited by placing the palm of the

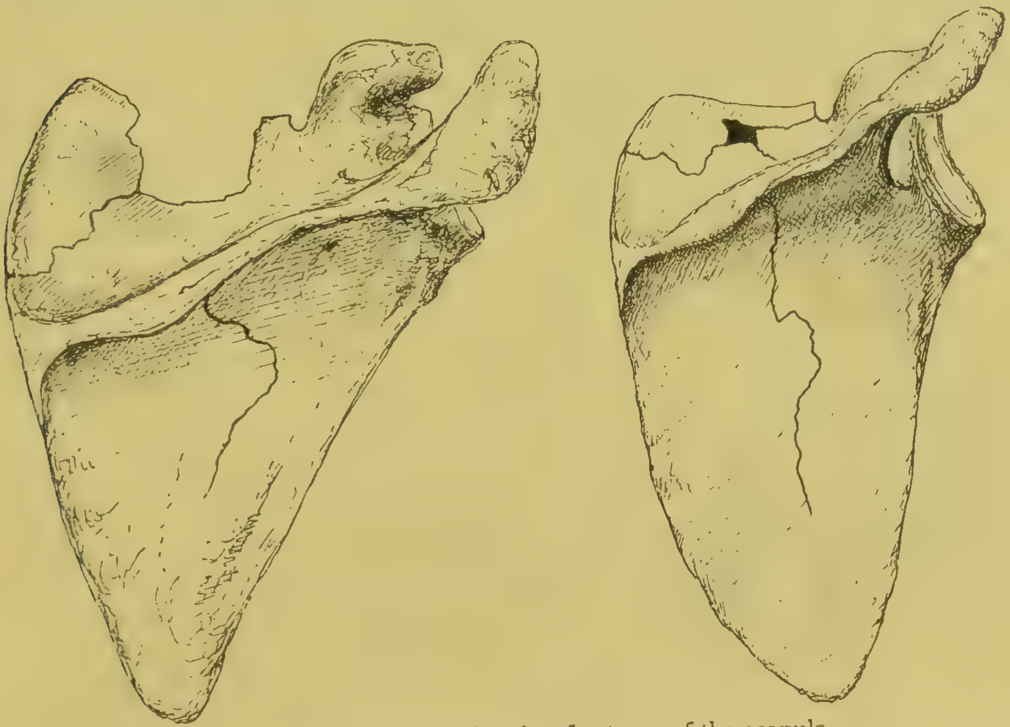

FIG. 140.—Two figures showing fractures of the scapula. (From the Museum of St. George's Hospital.)

hand over the bone and moving the shoulder, but it is by no means a constant sign. If the fracture has involved the spine, some irregularity of this process may be detected. The treatment consists in placing a thick fold of lint over the bone and strapping the side of the chest with strips of plaister. The arm must then be placed in a sling and bandaged to the side by a rib roller.

The **neck.**—Two different forms of injury are usually described as fractures of the neck of the scapula. One of these is where the fracture extends from the supra-scapular notch to the lower angle of the glenoid fossa. This is sometimes termed fracture of the surgical neck, and undoubtedly occurs, as it has been verified by dissection. About the other there is some doubt. It is usually termed fracture of the anatomical neck, and is said to consist of a fracture through the constricted portion of bone immediately beyond the glenoid cavity. This injury has never, so far as I am aware, been verified by dissection, and most of the cases in which it has been thought to occur were probably cases of fracture of the glenoid fossa itself, where a portion of this cavity has been broken off and the fracture has extended into the joint.

In the first and common variety of fracture the amount of deformity depends upon whether the coraco-clavicular and coraco-acromial ligaments have been ruptured or not. If they remain intact, there is little displacement; but if they are torn, the glenoid fossa, and with it the coracoid process, is displaced downwards into the axilla, and the injury simulates subglenoid dislocation of the humerus in the fact that there is flattening of the shoulder and apparent prominence of the acromion, with the presence of a foreign body in the axilla. The nature of the injury can be at once diagnosed by the alteration in the position of the coracoid process, by the presence of crepitus, and by the fact that on raising the arm the deformity disappears, but speedily recurs when the arm is allowed to drop. In the other form of fracture, the so-called fracture of the anatomical neck, the injury is produced by falls or blows on the shoulder, and is sometimes complicated with dislocation. It is to be diagnosed by well-marked crepitus elicited upon making any movement of the shoulder joint, and the absence of any signs indicating fracture of any of the other bones in the neighbourhood. There is inability to move the arm from the side, and sometimes slight lengthening. The **treatment** of the common fracture consists in placing a wedge-shaped pad in the axilla and binding the arm to the side; a large shoulder cap of gutta-percha or leather is then moulded to the joint, and the forearm and elbow are to be supported by a sling. In the fracture of the anatomical neck it is sufficient to place a pad in the axilla and bind the arm to the side. This fracture is likely to be followed by serious impairment of the movements of the shoulder joint.

The **acromion.**—The acromion is more frequently fractured than any other part of the scapula. The fracture is always produced by direct violence, and may be transverse or oblique, or the extreme tip may be broken off. The **signs** of this injury are well marked; there is pain, inability to raise the arm from the side, and dropping of the point of the shoulder. Upon tracing the subcutaneous surface of the process an irregularity will be felt, and on moving the shoulder crepitus and increased mobility will be detected. The injury may be mistaken for non-union of the acromial epiphysis and for chronic rheumatic arthritis of the shoulder joint. The **treatment** consists in raising the elbow and binding the arm to the side. A pad is placed in the axilla, and a bandage is then carried under the point of the elbow and over the opposite shoulder, and afterwards round the arm and chest.

The **coracoid process** is rarely fractured, and only from direct violence. There is little displacement, except in complicated injuries, when the coraco-clavicular ligament is torn as well. The **signs** are increased mobility of the fragment, and pain and crepitus on manipulation. The **treatment** consists in placing the forearm across the chest, with the hand on the opposite shoulder, and bandaging it in this position.

FRACTURES OF THE HUMERUS

For convenience of description **fractures of the humerus**, like fractures of the other long bones, are divided into (1) fractures of the upper extremity; (2) fractures of the shaft; and (3) fractures of the lower extremity.

1. The **fractures of the upper extremity** are those of (*a*) the anatomical neck; (*b*) the surgical neck; (*c*) separation of the greater tuberosity, and (*d*) separation of the epiphysis.

a. **Anatomical neck.**—Fracture of the anatomical neck is always the result of direct violence, such as blows or falls on the shoulder. It is sometimes designated 'intra-capsular,' but this is scarcely correct, as the line of the fracture usually lies partly within and partly without the capsule. It is frequently impacted, the upper fragment being driven into the lower. In the impacted fracture the deformity is usually considerable. There is some shortening of the arm and apparent projection of the acromion, with flattening of the shoulder beneath, but the head of the bone can be felt in the glenoid cavity. There is loss of power, pain and swelling about the shoulder, but no crepitus. In the non-impacted form there is less deformity, some slight irregularity about the shoulder, and generally about half an inch of shortening. The head of the bone can sometimes be felt on the inner side of the joint, unless the swelling, which is sometimes very considerable on account of the direct nature of the injury, obscures it. It has been said that necrosis of the upper fragment may occur, but this complication very rarely, if ever, takes place, as it remains attached to the rest of the bone by a few shreds of capsule, through which it obtains sufficient blood to maintain its vitality. Cases have been recorded where in this fracture the head of the bone becomes twisted round, so that its cartilaginous surface rests against the broken end of the lower fragment; and others where it has been forced into the axilla through a rent in the capsule.

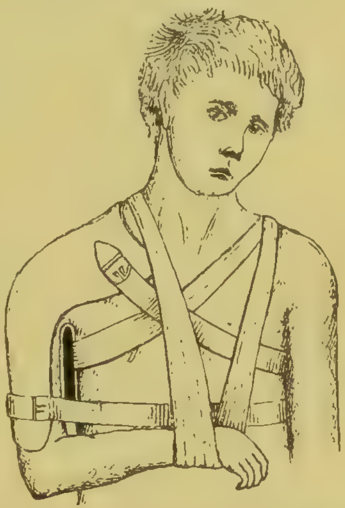

FIG. 141. Figure showing the treatment of a case of fracture of the neck of the humerus.

Treatment.—If there is much swelling and ecchymosis it is better to support the shoulder on a soft pillow for a few days, with extension from the elbow, and apply evaporating lotions. Then a ∩-shaped splint of leather or gutta-percha should be placed in the axilla, and maintained in position by a silk handkerchief inserted in the concavity of the splint and tied over the opposite shoulder. A moulded splint is now to be fitted over the shoulder and upper part of the arm and bandaged on (fig. 141). The injury is liable to be followed by considerable impairment of movement of the shoulder joint, to obviate which massage should be practised from the first, and passive movements begun at the end of a week or ten days. In cases where impaction exists no attempt should be made to disengage the fragments; all that is required is to bandage the arm to the side, support the elbow, and commence gentle passive movements early.

b. **Surgical neck.**—The fracture through the surgical neck is generally transverse, and may be impacted or non-impacted. When impacted the lower fragment is driven into the loose cancellous tissue of the upper. The displacement of the ends of the bone is twofold. The upper fragment is rotated outwards and drawn upwards by the muscles inserted into the great tuberosity; while the lower fragment is drawn inwards and forwards by the pectoralis major and teres major, and upwards by the biceps, triceps, coraco-brachialis, and deltoid. The signs of the non-impacted variety of fracture are sufficiently obvious. The axis of the limb is altered, being directed upwards and inwards towards the coracoid process, and here a distinct prominence, the upper end of the lower fragment, can be felt. There is no apparent projection of the acromion, but a hollow on the outer side of the arm just below the lower end of the upper fragment. The head of the bone can be felt in its normal position. The arm is shortened and there is increased mobility. As a rule crepitus is easily detected. Pain shooting down to the fingers is often complained of, from irritation of the nerves of the brachial plexus by the broken ends of the bone. When the fracture is impacted the signs are very obscure. There is slight shortening, deformity, and alteration in the axis of the limb, and the diagnosis has usually to be made by a process of exclusion of dislocation and the ordinary fractures of the neck of the humerus after a severe injury to the shoulder.

Fractures of the surgical neck of the humerus may be complicated by injury to the axillary vessels or the nerves of the brachial plexus, especially the circumflex, as it winds round the neck of the bone. Or this nerve may be later on implicated in the callus which is thrown out, and its functions impaired or destroyed.

The **treatment** of this fracture is much the same as that of fracture of the anatomical neck; but the elbow must be carried well forwards over the front of the chest, so as to force the upper end of the lower fragment backwards and outwards, and only the hand should be supported in a sling, so that the weight of the elbow may drag down the lower fragment and overcome the shortening. Passive motion requires to be commenced early, so as to prevent stiffness of the joint.

c. **Separation of the greater tuberosity.**—This injury may occur from direct violence applied to the shoulder, or in connection with a dislocation forwards of the humerus (see fig. 180). It is said also sometimes to occur from the violent contraction of the three muscles inserted into it. The tuberosity is displaced upwards and backwards by the supra-spinatus, infra-spinatus, and teres minor, while the shaft of the bone is drawn upwards and inwards by the subscapularis and other muscles. An increase in the breadth of the shoulder is thus produced. The tuberosity can be felt at the outer and back part of the joint and the head of the bone to the inner side, beneath the coracoid process, and between the two is a distinct sulcus. If the arm is drawn down and rotated, while the finger and thumb grasp the outer prominence, distinct crepitus will be felt.

Treatment.—A pad is placed in the axilla and the arm bound to the side; the tuberosity is then pushed downwards and forwards as far as possible, and maintained in this position by a pad and strapping. It has been suggested in these cases to cut down on the fragment and wire, or peg it into position. This is scarcely necessary, for though union usually takes place with a certain amount of deformity, the movements of the arm are very little interfered with, and a useful limb is generally obtained.

d. **Separation of the epiphysis.**—This accident is not of infrequent occurrence: it may be caused by direct violence; by a sudden pull on a child's arm; or by falls on the elbow or hand. In some cases there is little or no displacement, but usually the shaft of the bone is drawn inwards, and its extremity produces a characteristic prominence on the front of the shoulder a little below the coracoid process. The prominence is smooth and rounded, and not so sharp and irregular as a fractured bone. The head of the bone can be felt in the glenoid cavity, but it does not move on rotating the arm. During manipulation a soft crepitus may be felt. The deformity can readily be overcome by extension, but speedily returns when the extension is withdrawn.

Treatment.—The same treatment which is employed for fracture of the surgical neck—a pad or ∩-shaped splint in the axilla and a shoulder cap—is generally sufficient to maintain the fragments in apposition. If not, the patient must be confined to bed, his arm supported in a position of abduction by sandbags, and weight extension applied to the arm.

2. **Fracture of the shaft of the humerus.**—Fracture of the shaft of the humerus is of frequent occurrence, and may arise either from direct or indirect violence or from muscular action. Of all the long bones perhaps this is the one which is most frequently fractured from muscular action, such as throwing a stone or cricket ball. The fracture may occur at any point of the shaft, but the two most frequent situations are immediately above or below the point of insertion of the deltoid muscle, and the displacement differs in accordance with the situation of the fracture. When it takes place above the insertion of the deltoid, the upper fragment is drawn inwards by the pectoralis major and the latissimus dorsi, and the lower fragment upwards and outwards by the deltoid (fig. 142). If the fracture is below the insertion of the deltoid, the upper fragment is drawn outwards by that muscle and somewhat tilted forwards, and the lower fragment is drawn upwards by the biceps and triceps, and lies to the inner side of the upper fragment.

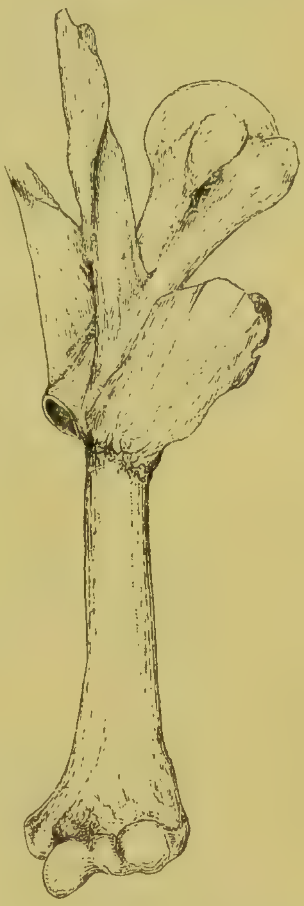

FIG. 142.—Fracture of the shaft of the humerus, above the insertion of the deltoid muscle, showing the displacement which takes place and the muscles by which it is caused. (From the Museum of St. George's Hospital.)

The **signs** of this fracture are unmistakable; the arm lies helplessly by the patient's side, and he is unable to move it. The increased mobility and the presence of crepitus at once indicate the nature of the injury.

There are two special points of interest about fractures of the shaft of the humerus which require mention: one of these is the involvement of the musculo-spiral nerve, which may be injured by the broken ends of the bone or may subsequently become included in the callus; the other is the frequency of non-union after fracture. Many causes have been assigned for this, but the most probable is the difficulty in fixing the upper end of the bone and so procuring immobility of the upper fragment.

Treatment.—The usual mode of treatment which is recommended for fracture of the shaft of the humerus is an internal angular splint reaching from the axilla to the wrist, and three short lateral splints to the arm. This is entirely wrong because it does not fix the upper fragment. The only way to secure immobility is by employing some form of splint which will fix the shoulder joint. The most convenient form is a poro-plastic splint moulded to the shoulder and covering it both in front and behind, and carried down the arm as far as the bend of the elbow. The displacement is first overcome, and while extension is still being kept up, the splint is rapidly moulded to the shoulder and arm, and a short lateral wooden splint is applied on the inner side and the two securely bandaged in position. The hand, not the forearm, is now placed in a sling, so that the weight of the elbow may drag down the lower fragment, and the arm is fixed to the side by a broad belt or bandage (fig. 143).

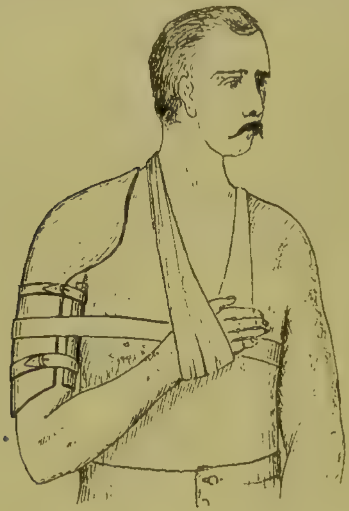

FIG. 143.—Figure showing the treatment of fracture of the shaft of the humerus. The bandage fixing the shoulder cap is not represented for the sake of clearness.

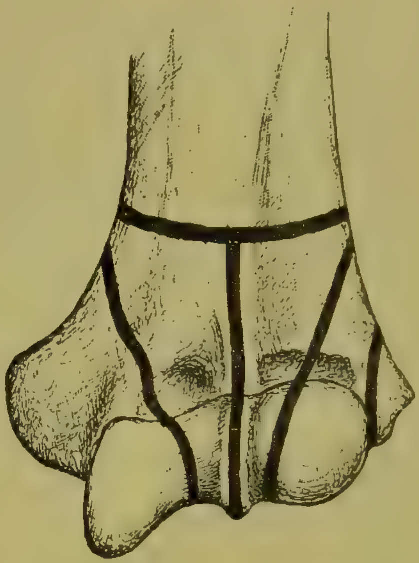

FIG. 144.—Diagram showing the more common forms of fracture of the lower end of the humerus.

3. **Fractures of the lower end of the humerus.**—The usual fractures of the lower end of the humerus are: (*a*) Transverse fracture above the condyles; (*b*) fracture of either condyle; (*c*) T- or V-shaped fracture; (*d*) separation of the epiphysis (fig. 144).

a. **Transverse fracture above the condyles** is by no means an uncommon accident, especially in early life. It may be produced by falls on the hand, with the forearm bent, when the displacement is backwards; or by falls on the elbow, when the displacement may be either backwards or forwards. The diagnosis of this injury is sometimes difficult, and is liable to be mistaken for dislocation of the bones of the forearm backwards. In the displacement backwards the forearm is flexed and the hand pronated. The olecranon projects behind, and there is a flattening or hollow above it. The movements of the elbow are impaired, but not abolished. Crepitus can be detected by extending the forearm. The diagnosis from dislocation may be made by comparing the relation of the olecranon to the condyles with the same bony points on the other side, but this is not always easy on account of the great and rapid swelling which takes place. Another point of distinction is the prominence in front of the elbow, which in fracture is above the level of the elbow joint and is produced by the lower end of the upper fragment, whereas in dislocation the prominence, due to the articular end of the bone, is opposite the crease of the joint. In addition to this in fracture the deformity is easily overcome by extension, and crepitus is generally detected during the process; but it at once recurs on the extension being withdrawn. In dislocation the reduction is not so easy, but once being effected, the bone remains in position. In the displacement forwards the deformity is different. A prominence will be felt beneath the tendon of the triceps, caused by the lower end of the upper fragment; while in front and above the joint the projection of the upper end of the lower fragment will be plainly perceived.

Treatment.—After reduction the arm is to be put up in an anterior angular splint, with a straight splint on the back of the arm, which should project a little beyond the level of the olecranon. The forearm must be in a position midway between supination and pronation.

b. **Fracture of the condyles.**—Fracture of either condyle may take place, but the external condyle is more frequently broken than the internal. The fractures are generally the result of direct violence, but may also be produced by indirect force, more especially that of the outer condyle. This accounts for the greater frequency of fracture in this situation.

Fracture of the external condyle.—The line of fracture generally runs from the external condylar ridge downwards and inwards to the groove which separates the capitellum from the rest of the articular surface (fig. 144). When it is the result of indirect violence, it is produced by falls on the hand, the head of the radius being driven against the capitellum. The fracture always involves the elbow joint. The displacement is not great, the fractured portion of bone being retained in position by the external lateral ligament. There is great pain and swelling, at first confined to the outer side of the joint, and crepitus is readily obtained by grasping the condyle, and moving it slightly on the subjacent bone.

Fracture of the internal condyle.—Two fractures of the internal condyle may occur: one, intra-articular; the other, extra-articular. The *intra-articular fracture* extends from the internal condylar ridge downwards and outwards to the middle of the trochlear surface (fig. 144). The fractured portion of bone is displaced a little upwards and backwards, carrying the ulna with it, so that when the forearm is extended the olecranon projects behind the humerus, and the forearm is deflected to the ulnar side. The elbow becomes swollen and painful, there is increased breadth between the condyles, and crepitus can be detected by seizing and moving the broken portion of bone. The movements of the elbow are impaired. The *extra-articular fracture* (epicondylar fracture) is where the tip of the condyle is broken off, generally from direct violence, though it is said to occur from muscular action. As it usually occurs in young children, it is probably a separation of the ossific centre for the internal condyle. The fragment is drawn downwards by the muscles attached to it, and can be felt as a loose nodule of bone, which is movable, and on movement induces a sensation of crepitus. These fractures are to be treated by an anterior angular splint, with a pad and strapping over the displaced fragment to keep it in position. Massage and passive motion should be employed from the first, as there is a great tendency for stiffness of the elbow joint to follow the injury.

c. **T- or V-shaped fracture.**—Two very similar but at the same time slightly different fractures are included under this head. The one, the V-shaped fracture, is a complicated form of the preceding variety of fracture, since it is a separation of both condyles from the shaft of the bone; the fracture extends from the middle of the articular surface in two directions—one line passes upwards and outwards to the external condylar ridge, the other upwards and inwards to the internal condylar ridge; both condyles are therefore separated from the shaft of the bone and from each other. In the other form, the T-shaped fracture, there is a transverse supracondyloid fracture, and a vertical fracture running from it into the joint, and separating the two condyles from each other. These fractures are always the result of direct violence, and are serious injuries, being followed by great swelling and inflammation, often resulting in permanent deformity and ankylosis. There is increased breadth of the joint, crepitus is felt by moving the fragments on each other, or by flexing the forearm.

Treatment.—These are cases in which massage and passive movement early are especially indicated. The bones should be manipulated into as good a position as possible, and the limb, with the forearm flexed to a right angle, laid on a firm pillow and secured with bandages. Gentle massage should then be applied in an upward direction every day, and at the end of the first week careful passive motion, the hand grasping the fragments to prevent any movement between them.

d. **Separation of the epiphysis.**—When separation of the lower epiphysis of the humerus takes place, the whole of the lower end of the bone, which is ossified from four distinct centres, is usually separated from the shaft. But cases are said to occur where the articular surface of the bone is alone separated, and the two condyles remain attached to the shaft. In this injury the lower end of the bone is displaced backwards, carrying with it the bones of the forearm; it is therefore very liable to be mistaken for dislocation of the radius and ulna, or for supra-condyloid fracture of the humerus. The fragments are, however, smoother and rounder than in fracture, and the crepitus is less marked. There is seldom any difficulty in overcoming the deformity, but often considerable difficulty in retaining the parts in correct position. The treatment is the same as for supra-condyloid fracture.

FRACTURES OF THE ULNA

The ulna may be broken in many situations. The olecranon and coronoid processes may be broken off, or the shaft may be fractured in any part, or the styloid process may be separated from the rest of the bone.

a. **The olecranon.**—The olecranon is usually fractured by direct violence, but may also be broken by the violent contraction of the triceps muscle. The most common situation for the fracture to take place is where the process is somewhat constricted, just before it joins the rest of the bone, but a thin shell may be torn off by the action of the triceps. The fracture is sometimes comminuted, when the injury is produced by direct violence, but the line of fracture is most frequently transverse. There is considerable displacement from the loose fragment being drawn up by the triceps muscle (fig. 145). If the case is seen soon after the injury, it will be noticed that the prominence of the elbow is replaced by a depression, but usually there is so much swelling from extravasation of blood and effusion into the joint that this is obscured. The separation of the broken fragments can usually be ascertained by burying the fingers in this soft swelling, and will be found to be increased on flexing the forearm. No crepitus can be felt unless the fractured process is drawn down into contact with the rest of the bone. In some cases the ligamentous tissues around are not ruptured, and then no depression will be present, but there will be loss of power in the arm, and crepitus will be easily obtained.

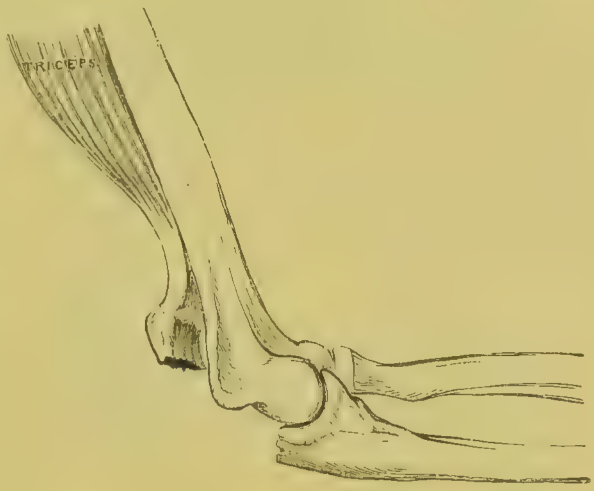

FIG. 145.—Fracture of the olecranon, showing the displacement caused by the action of the triceps. (From Gray's 'Anatomy.')

Treatment.—There can be no doubt that the plan of treatment which yields the best results is to expose the fracture by a longitudinal incision; clear away all blood clots and shreds of tissue which overhang the fractured surfaces, and then wire them together with a silver wire. Holes are drilled in the bones by a bradawl, introduced on the posterior surface of the bone and carried obliquely through its thickness to emerge on the fractured surface close to the articular cartilage. The holes must correspond to each other, so that when the bones are brought together the two fragments will be in the same plane. A silver wire is then introduced, the two fragments are approximated, the wire twisted, cut off short, and the ends buried in the periosteum. If the surgeon is confident of his powers to carry this proceeding through aseptically, and especially if the patient is young, vigorous, and of sound health, this is the plan of treatment which should be adopted. If, however, from any cause, it is thought to be desirable not to operate, the fragments should be approximated by strapping or figure-of-8 bandage as far as possible, and the arm put up on a straight anterior splint. If there is much swelling it is better to defer the application of the bandage until it has subsided. At the end of a fortnight or three weeks the forearm should be gently flexed, with the thumb pressing on the top of the olecranon to prevent the union giving, and the arm put up on an angular splint. The union under these circumstances is fibrous, and ankylosis is very likely to result.

In cases where the fragments have been wired passive motion may be begun gently at the end of a week; but in those in which the injury has been treated by splints, passive motion cannot be undertaken until there is a fair amount of union, and will have to be persevered with for a very considerable period.

b. **The coronoid.** Fracture of the coronoid process undoubtedly occurs sometimes as a complication of dislocation of the forearm backwards, but is by no means a necessary accompaniment of this lesion. Whether it ever occurs as an uncomplicated injury is exceedingly doubtful. Should it occur as a complication of dislocation, its presence would be manifested by the reduction being easier than is usually the case, and by being accompanied by crepitus. There is also a great tendency to recurrence of the displacement after reduction. In those cases where this injury is suspected the forearm should be put up in the flexed condition; but as the future mobility of the elbow joint is of much more importance than accurate bony union, passive motion should be commenced early.

c. **The shaft of the ulna.**—Fracture of the shaft of the ulna may occur at any part, but usually takes place at about the middle of the bone or a little below, and is the result of direct violence. The displacement is usually very slight, or there may be none at all; the upper fragment may be drawn forwards by the brachialis anticus, and the lower approximated to the radius by the pronator quadratus. If this displacement has taken place the diagnosis is easy, for on running the finger down the posterior subcutaneous border of the bone an irregularity is at once detected. When there is no displacement, fixed pain in the part, bruising, increased mobility and crepitus elicited by making pressure alternately on either side of the painful spot, will indicate the nature of the lesion. The **treatment** consists in applying two short splints to the forearm, with the hand in a position midway between pronation and supination.

d. The **styloid process** may be broken off by direct violence, or as a complication of Colles' fracture. It is usually much displaced, and can be felt as a movable fragment some distance from its normal position. It must be manipulated into place and fixed there with strapping.

FRACTURES OF THE RADIUS

Fracture of the radius may take place through the head, the neck, the shaft, or the lower extremity, the latter being the most common.

a. **Fracture through the head** is usually the accompaniment of some other injury to the bones in the neighbourhood of the elbow joint, but in rare instances it may be split longitudinally or broken up into fragments. If the orbicular ligament remains intact there is little displacement, and the injury is diagnosed by the loss of movement, and by crepitus being produced upon pronating and supinating the forearm. The treatment consists in keeping the part at rest on an angular splint and employing early passive motion.

b. **Fracture through the neck** is a rare injury. When it occurs the lower fragment is drawn upwards and forwards by the biceps and forms a projection at the front of the elbow; all power of pronation and supination is lost, and crepitus is felt on passively rotating the bone, and the head cannot be felt to revolve in the lesser sigmoid cavity. The **treatment** consists in fixing the arm in a flexed position to relax the biceps. If this does not prove sufficient to reduce the displacement of the lower fragment, a pad placed over the projection beneath an anterior angular splint will press it into position. Passive motion must not be commenced too early for fear of stretching the soft callus and causing a return of the displacement.

c. **Fractures of the shaft** may be caused by either direct or indirect violence, and are of frequent occurrence. They require to be considered under two heads, viz. fractures above the insertion of the pronator radii teres, and fractures below the insertion of this muscle. In the former class the displacement is peculiar, inasmuch as the two principal supinators, the biceps and supinator brevis, are attached to the upper fragment and the two pronators to the lower. Hence it follows that the upper fragment is in a position of supination and at the same time flexed, while the lower fragment is in a state of pronation and drawn towards the ulna. If such a fracture is put up in the ordinary position, midway between pronation and supination, union will take place with the upper fragment fully supinated and the lower semi-pronated, and the movements of the wrist and hand will be materially impaired.

When the fracture is below the insertion of the pronator radii teres the same extreme supination of the upper fragment is not present, as the action of the supinators is counteracted by this muscle, and therefore the fragment is in a condition midway between supination and pronation, and the fracture may be put up in the ordinary way. The lower fragment is, however, drawn forcibly inwards towards the ulna by the pronator quadratus and by the supinator longus tilting the upper end inwards, and therefore union of the lower fragment to the ulna is the evil to contend against (fig. 146). The signs of these fractures are fixed pain, inability to rotate the bone, crepitus, and increased mobility. Irregularity in the outline of the bone can generally be detected.

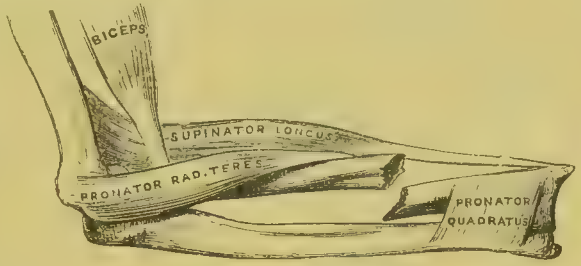

FIG. 146.—Fracture of the shaft of the radius, below the insertion of the pronator radii teres, showing the displacement which takes place and the muscles by which it is caused. (From Gray's 'Anatomy.')

Treatment.—In fractures above the insertion of the pronator radii teres the hand and lower fragment must be brought into a position of supination and maintained there, since it is impossible to deal with the upper fragment and overcome its position of supination. The forearm is to be flexed to a right angle and placed on a posterior angular splint with the palm uppermost: a short straight splint is then to be applied to the flexor surface of the forearm and the two splints bandaged. In the fracture below the insertion of the pronator radii teres the fracture may be put up in the ordinary way with two short splints, palmar and dorsal, and the forearm midway between supination and pronation, but a thick interosseous pad should be placed between the limb and the splint to prevent union of the lower end of the fractured bone with the ulna.

d. **Fracture of the lower end of the radius** is generally known as *Colles' fracture*; it is a fracture across the lower end of the bone, about an inch from its articular extremity. It is of common occurrence, and occurs most frequently in women of advanced age, but may occur at any age or in either sex. It always arises from falls on the palm of the hand. The fracture is generally transverse, or only slightly oblique in a lateral direction, but in the antero-posterior direction there is a considerable obliquity, the fracture passing from below upwards and backwards.

The displacement of the lower fragment is threefold: 1. The lower fragment is displaced backwards and upwards; but inasmuch as the displacement backwards is not sufficient for the lower fragment to clear the upper, the upward displacement results in impaction. 2. It is rotated backwards through a transverse axis drawn through the line of fracture, so that its articular surface is directed backwards and downwards, instead of directly downwards. 3. The outer border of the lower fragment is displaced backwards and upwards to a greater extent than the inner border. This arises from the latter border being fixed by the inferior radio-ulnar ligaments to the lower end of the ulna, and perhaps also to the greater force of the concussion being communicated to the outer border of the bone, since the main violence of the fall is received on the ball of the thumb. In consequence of this the hand is abducted to the radial side. In addition to this displacement of the lower fragment, the upper one is drawn towards the ulna and pronated by the pronator quadratus.

It would appear probable that in every case of Colles' fracture the upper fragment is driven into the cancellous tissue of the lower. It may become fixed there, producing the impacted fracture, which is the more common condition, or it may break up the lower fragment into two or more pieces, and then no fixation takes place (fig. 147).

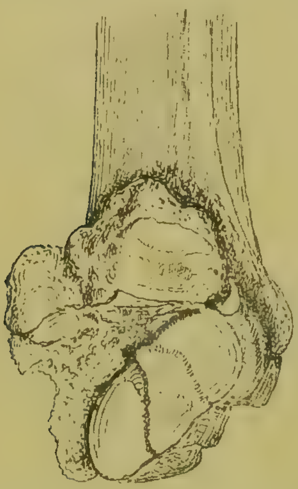
FIG. 147.—Colles' fracture of the radius, with comminution of the lower fragment. (From a preparation in the Museum of St. George's Hospital.)

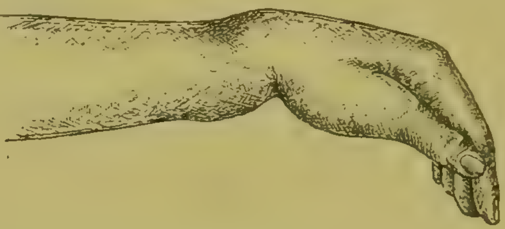
FIG. 148.—Figure showing the characteristic deformity in Colles' fracture.

The deformity produced is a very characteristic one. The fingers are bent on the hand in a position of pronation. On the back of the wrist is a projection, which rises above the level of the carpus and terminates abruptly above in a sudden hollow. On the palmar surface, corresponding to the projection on the dorsum, is a well-marked hollow, surmounted above by an abrupt elevation, caused by the lower end of the upper fragment (fig. 148). This deformity is sometimes known as the 'silver fork displacement,' from its resemblance to this article. In addition to this there is marked radial abduction of the hand, and the styloid process of the ulna stands out prominently under the skin. The hand appears to be hyper-extended at the wrist, from the direction which the articular surface has assumed. The power of pronation and supination is lost, and much pain is complained of. In the majority of cases there is no crepitus or preternatural mobility—these are the impacted cases;

in the minority there is well-marked crepitus and increased mobility—these are the cases where the lower fragment has been broken up. An excellent diagnostic sign in recognising this fracture, and also in differentiating it from dislocation, for which it may be mistaken, is to compare the relative positions of the styloid processes of the radius and ulna. In the natural condition, when the arm is hanging by the side, the styloid process of the radius is at a lower level than that of the ulna; in Colles' fracture the styloid process of the radius is on the same level or actually higher than that of the ulna.

These fractures unite readily, but are very liable to be followed by stiffness and impairment of motion of the fingers, from the tendons which run in the grooves at the back of the lower end of the radius becoming fixed in the inflammatory exudation.

Treatment.—Perhaps there are no fractures which illustrate the advantages of early massage and passive motion so well as do these cases of fracture of the lower end of the radius, and this plan of treatment should always be adopted. In the first instance an attempt should be made, in most cases at all events, to disimpact the fragments and reduce the deformity. This in all cases may not be possible, but in the majority of them, by flexing the forearm and making forcible extension, with the hand supinated and adducted, the deformity will be overcome. Gentle massage in an upward direction should then be performed until the pain is relieved, and the limb should be confined on a couple of ordinary splints, palmar and dorsal. The massage should be repeated daily, and at the end of a week passive movements of the various joints of the fingers and the wrist be begun, the splints being reapplied after each sitting. At the end of a fortnight the splints may be discarded, the arm being carried in a sling, and at the end of a month the bones will be found fairly united, and there will be perfect movement of the joints in every direction.

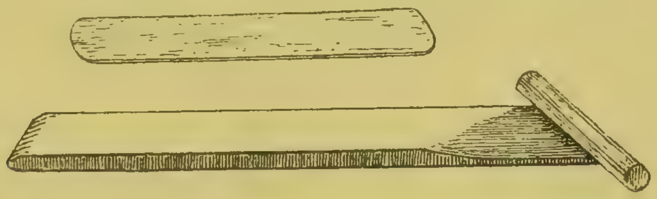
FIG. 149.—Carr's splint for Colles' fracture. Left side.

Many different forms of splint have been employed in the treatment of this form of fracture, such as Nelaton's pistol-shaped splint; Gordon's splint; Carr's splint; and two straight splints, not extending beyond the knuckles, so that the weight of the hand keeps up a condition of adduction. It will be sufficient to describe here Carr's splint, which is certainly the best and the one most commonly used. The shape of the splint will be readily understood from the accompanying illustration (fig. 149). It consists of a narrow splint hollowed out for the thenar eminence, to the end of which is attached an oblique rod about four inches long. This is applied to the palmar surface of the forearm, so that the rod corresponds to the metacarpo-phalangeal joints, and is grasped by the fingers. A second short splint is applied to the dorsal surface. These splints are fixed by strapping in such a way that the fingers are free to move.

There is another variety of fracture of the lower end of the radius, in which the displacement is forwards instead of backwards. This is caused by falls on the dorsum of the hand.

e. **Separation of the lower epiphysis of the radius** is not an uncommon accident, and occurs in children from the same form of injury which produces Colles' fracture in the adult. The deformity, however, is different, for the displacement is directly backwards, and there is no radial abduction or prominence of the styloid process of the ulna. The injury more nearly simulates dislocation of the carpus backwards, but may be distinguished from it by the alteration in the relative positions of the styloid processes of the radius and ulna.

Fracture of both bones of the forearm may occur from either direct or indirect violence, more commonly from the former, inasmuch as when indirect force is applied to the bones, the radius as a rule only suffers. The fracture may occur at any part of the bones, but more commonly in the lower than the upper half. In many cases it occurs about an inch above the wrist joint, and is then a Colles' fracture plus a fracture of the lower end of the ulna. This injury requires to be differentiated from Colles' fracture, as the displacement is different and is principally due to muscular action. The radius is pronated by the pronator radii teres, and the two bones approximated by the pronator quadratus; the lower fragment is drawn upwards by the supinator longus. In fracture of both bones higher up, the displacement varies according to the direction of the fracture and the amount of force applied. When the fracture is transverse, as is usually the case, and the laceration of the tendinous and muscular structures around has been slight, there is little displacement; when the fracture is oblique and considerable force has been exerted, extreme displacement with overlapping of the fragments may be present. In these fractures there is great pain and loss of power in the limb. Where there is displacement there is shortening and deformity. In all there is increased mobility and crepitus. **Treatment** consists in reducing any displacement which may exist, and putting the forearm up in two splints, anterior and posterior, in a position midway between supination and pronation, unless the fracture is high up, above the insertion of the pronator radii teres to the radius, when the fracture should be put up with the bones of the forearm in a position of supination, as described in speaking of fractures of the radius alone (page 437).

In dealing with fractures of the bones of the forearm, the surgeon should always have present in his mind the great tendency there is in these cases to the occurrence of gangrene from compression of the vessels from too tight bandaging, and should always keep his eye on these cases for two or three days after the injury. This caution is the more necessary as these cases in hospital practice are treated as out-patients, and after the fracture is put up the patient may not attend again for some days, unless especially requested to do so.

Fractures of the carpal bones are of rare occurrence, and are generally the result of severe crushing violence. They are therefore usually complicated by so much injury of other structures as to require amputation. Where this is not so, owing to their extensive ligamentous attachments, there is little displacement. The signs are extensive bruising, loss of movement, pain and crepitus on manipulation. The hand requires to be confined on a splint, and massage and early passive motion employed.

Fractures of the metacarpal bones not uncommonly occur from direct violence. The fracture is generally transverse or slightly oblique, and may be attended with no displacement or the displacement may be considerable, the two fragments forming an angle with each other on the back of the hand. When the fracture occurs near the distal extremity, the head of the bone is carried forwards with the finger and thus simulates a dislocation. The irregular outline of the bone, with pain, crepitus, and bruising, sufficiently indicates the nature of the injury. An anterior splint, with a pad in the palm between it and the splint, is generally all that is required.

Fractures of the phalanges are generally compound. If simple they may be recognised by the increased mobility, crepitus, and displacement of the bones. The treatment consists in applying a narrow splint and fixing it with strapping, or in moulding a gutta-percha shield to the finger.

FRACTURES OF THE LOWER EXTREMITY

Fracture of the femur.—For convenience of description it is customary to divide fractures of the femur, like the other long bones, into fractures of (1) the upper end, (2) the shaft, and (3) the lower end.

1. **Fractures of the upper end** are divisible into (*a*) fracture of the neck of the femur, (*b*) fracture at the junction of the neck with the trochanter, (*c*) separation of the great trochanter, (*d*) fracture through the great trochanter, (*e*) separation of the epiphysis of the head of the bone (fig. 150).

a. **Fracture of the neck of the femur.**—This fracture is usually known as 'intra-capsular' fracture of the neck of the femur, but this designation is not strictly correct, as in some of these cases the fracture is not completely within the capsular ligament. It is for the most part transverse, but may be slightly oblique. It is usually non-impacted, but very occasionally impaction may occur, the neck being driven into the loose cancellous tissue of the head.

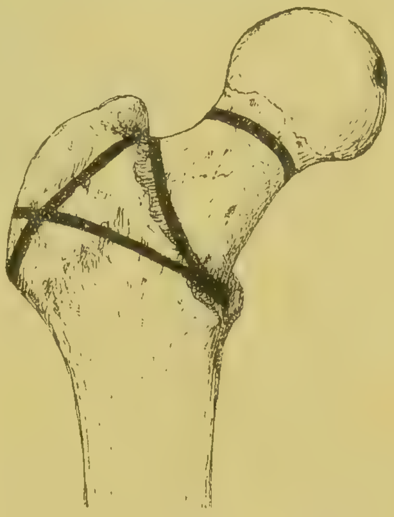

Fig. 150.—Diagram showing the more common fractures of the upper end of the femur.

This fracture is an injury of advanced life, being rarely met with in persons under fifty years of age, and is much more common in the female than the male. It is always the result of indirect violence, and usually results from some trivial accident producing a wrench or strain, as catching the toe in some inequality in the ground, which causes the patient to stumble and the bone to give way. The reason it occurs in old people is no doubt due to degenerative changes in the cancellous tissue, and the absorption of the 'calcar femorale,' which, according to Merkel, sustains the greatest amount of pressure when the body is in the erect position. It is sometimes said that the angle between the neck and the shaft is lessened as age advances, and that this is a cause of the frequency of fracture in old age, but it is very doubtful if this is so. The greater frequency of its occurrence in females is due to the greater width of the pelvis in this sex.

In consequence of this the angle which the neck forms with the shaft more nearly approaches a right angle, and there is therefore greater strain on the neck of the bone in supporting the weight of the trunk. The displacement which takes place is entirely due to alteration in the position of the lower fragment, which is drawn upwards by the glutei, rectus femoris, and hamstring muscles, and rotated outwards principally by the weight of the limb, but also to a certain extent by the external rotators inserted into the great trochanter (fig. 151).

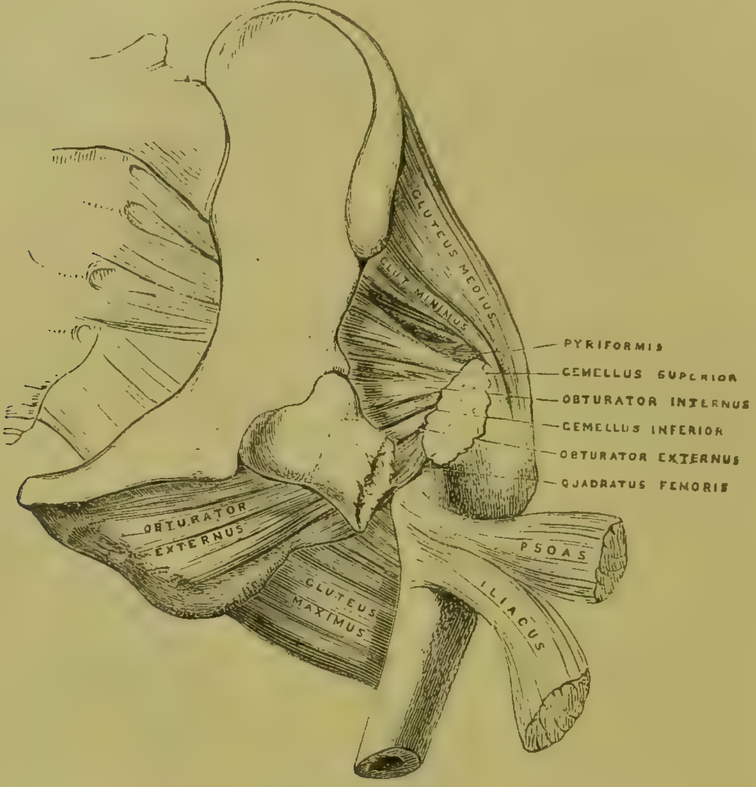

FIG. 151.—Fracture of the neck of the femur, showing the displacement which takes place from muscular action. (From Gray's 'Anatomy.')

Signs.—The position of the patient as he lies on the bed is very characteristic in fracture of the neck of the thigh bone. The limb is shortened and rests on its outer side, with the knee somewhat flexed, and there is a general appearance of deformity and flattening about the hip. The principal signs are: (1) alteration in the shape of the hip; (2) alteration in the direction of the axis of the limb; (3) shortening; (4) pain; (5) possibly crepitus; (6) loss of power.

Alteration in the shape of the limb is due to alteration in the position of the trochanter major, which is displaced upwards and inwards and sunken, so that it does not appear to be as prominent as natural. On rotating the thigh, it does not describe the segment of a circle, as it does on an uninjured limb, but simply rotates under the finger. The alteration which is noticed in the direction of the axis of the limb is that the shaft of the bone is everted and rotated outwards, so that the limb rests on its outer side in an apparently helpless condition. The shortening is never very great, rarely exceeding an inch, the amount of shortening depending on the amount of laceration of the reflected portion of the capsular ligament. Where this remains untorn, no shortening exists. Occasionally the shortening, which may have been slight shortly after the injury, increases as time goes on. This is probably due to the reflected portion of the capsular ligament giving way from inflammatory softening or injudicious manipulation on the part of the attendant, or efforts to move the limb on the part of the patient. The pain in fracture of the neck of the femur is not very severe. Crepitus is often absent, or if present is not well marked. No effort should be made by rough manipulation to elicit it, as it is not necessary as an aid to diagnosis. There is always more or less loss of power: sometimes it is complete; in others, owing to the reflected portion of the capsular ligament remaining untorn, the patient may be able to raise his limb, or even to bear his weight on it.

In the impacted fracture the symptoms are less marked, and there is often some difficulty in diagnosing this injury from simple contusion of the hip. But there is always a certain amount of shortening, varying from half an inch to an inch, and this shortening cannot be overcome by extension, unless such an amount of force is used that the fragments are disengaged, and this should never be done. There is less eversion than in the non-impacted fracture, and the loss of power is not so great; in fact, in some of these cases the patient has been known to walk and bear his weight on the limb. There is, of course, no crepitus.

The most frequent mode of union in cases of fracture of the neck of the thigh bone is by fibrous tissue, but a certain percentage of cases unite by bone: in some instances no union takes place and the two surfaces become smooth and eburnated. In these latter cases the capsular ligament becomes much thickened, so that the patient is enabled to bear the weight of his body on the limb, the pelvis being supported by the thickened capsule. The absence of bony union in the majority of cases appears to depend upon the fact that the osseous surfaces are not in apposition,. for in those instances where the patient can be kept in bed for a lengthened period of time and extension applied so as to overcome the shortening, bony union appears to occur without difficulty: this is also the case in impacted fracture; but where the patient is feeble and cannot bear the necessary confinement and extension, fibrous union or no union at all is likely to ensue.

Fracture of the neck of the thigh bone occurring in an old person must always be regarded as a serious injury, and often terminates fatally. Owing to the necessary confinement to bed, hypostatic congestion of the lungs or sloughing of the back from pressure is very liable to occur and cause the death of the patient.

Treatment.—The treatment of fracture of the neck of the femur must depend in a great measure upon the constitutional condition of the patient. If he is fairly strong and vigorous, of a healthy temperament, and without any chronic lung trouble, an attempt should be made to obtain bony union. This is to be done by confining him to bed, with extension by means of a pulley over the end of the bed, and the limb supported by sandbags. He must be kept in this position for six weeks, and then the limb must be put up in some immovable apparatus and the patient allowed to go about on crutches. During this time he should be most carefully watched, and should he show any signs of bronchitis or any tendency to the formation of a bedsore the treatment must be at once abandoned, and the patient either raised in bed or allowed to get up daily and sit in a chair, the limb being left to take care of itself. If the patient is weakly, and especially if he shows any tendency to chronic bronchitis, he should only be confined to bed until the most urgent symptoms of pain have passed off, with the limb supported between sandbags. A Thomas's splint is then applied, and the patient allowed to get about on crutches. The Thomas's splint is a better appliance in these cases than an immovable splint either of plaster of Paris, leather, or any other material, as these splints are liable to produce sores in the old and feeble. In cases treated in this way the union will necessarily be fibrous, or no union may take place, but the patient will probably after a time be able to get about with the aid of a stick.

In cases where the fracture is impacted, no attempt should be made to disengage the impaction.

b. **Fracture at the junction of the neck with the trochanter.**—These fractures are often described as *extra-capsular*; but this term is quite incorrect, as the fracture in front is entirely within the capsule, though behind it is outside it. In front the line of fracture lies internal to the anterior intertrochanteric ridge to which the capsular ligament is attached.

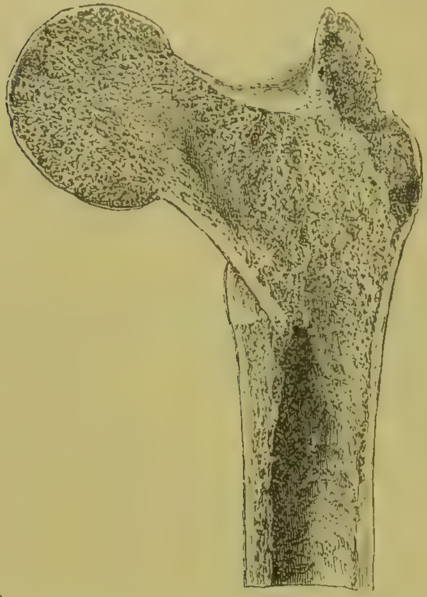
FIG. 152.—Impacted extra-capsular fracture of the neck of the thigh bone. (From 'A System of Surgery,' by Holmes and Hulke.)

This fracture is produced by direct violence, such as blows or falls on the hip, and is very frequently impacted (fig. 152). In fact, there seems very good reason to believe that in most, if not all of these cases, on account of the direction of the violence which produces the fracture, the neck of the bone is driven into the loose cancellous tissue, where it may either remain fixed, or may split up the trochanter and so no fixation takes place. These fractures are therefore very often comminuted.

The displacement is much the same as in the fracture of the neck, but is greater in amount, as there is nothing to oppose the force of muscular action on the lower fragment, which is drawn upwards by the combined action of the glutei, rectus femoris, and hamstring muscles.

Signs.—The signs by which a non-impacted extra-capsular fracture is recognised are very much the same as those of the intra-capsular variety, but they are very much more pronounced. The alteration in the shape of the limb and the shortening are much greater. The limb is more everted, and there is more displacement of the trochanter; the shortening is always more than an inch and generally exceeds two inches. The crepitus is well marked, and may readily be felt by laying the hand on the trochanter and rotating the thigh. There is complete loss of power to move the limb. Combined with these signs there is the history of a severe injury to the hip, as a fall from a height or blow upon it, and there is evidence of this injury in swelling and bruising about the part. The age of the patient may also be of some assistance in coming to a diagnosis between the two forms of fracture, the intra-capsular rarely occurring before fifty, and generally in feeble individuals, the extra-capsular occurring for the most part in young and vigorous adults. When the fracture is impacted, the signs are not so clear. There is the history of the injury to the hip and there is bruising about the part, with a fixed pain which is increased by any movement. The limb is generally everted, but may not be so, and may even be inverted, according to the position of the fragments at the moment of impaction. The trochanter is displaced upwards and inwards, and there is no crepitus. There is shortening generally to the extent of about an inch, which cannot be overcome by extension.

It will thus be seen that this impacted fracture resembles very much the fracture of the neck within the capsule, and there is often difficulty in diagnosing between the two. The main points of differentiation are the age of the patient, the degree and direction of the injury which caused the fracture, and the fact that the shortening can be overcome by extension in the intra-capsular fracture, but cannot in the impacted extra-capsular fracture.

In the diagnosis of these fractures, as well as in other injuries and affections of the hip, the position of the great trochanter is a sign of the greatest importance. It is desirable, therefore, to draw the attention of the student to two or three tests by which any alteration in the position of this process of bone may be demonstrated.

Nelaton's test.—The patient being laid in the supine position, with the limb extended in the axis of the body, a piece of tape is stretched from the anterior superior spinous process of the ilium to the most prominent part of the tuber ischii. If the trochanter is in its normal position, the middle of the tape ought just to skirt the upper border of the trochanter.

Bryant's test.—The patient being in the same position, a vertical line is dropped from the anterior superior spinous process of the ilium, and the distance between this line and the top of the great trochanter is compared with a similar measurement on the other side of the body.

Morris's test.—This is made by means of a rod, graduated from the centre, with sliding pointers. The rod is placed across the abdomen, so that its centre corresponds to the middle line of the body, and the pointers moved along it till they correspond to the outer surface of the great trochanter. The measurements on the two sides of the body can thus be compared. The advantage of this test is that it gives the amount of inward displacement, and it may be usefully employed in conjunction with Bryant's test, which denotes the amount of upward displacement.

Treatment.—The non-impacted fracture is to be treated by extension to overcome the shortening, and a long splint to keep the parts at rest and prevent the eversion. Extension is best applied by means of a pulley and weight fixed to the end of the bed. The weight should be attached to the limb by a stirrup applied to the thigh and not to the leg, to prevent stretching the ligaments of the knee, and for a healthy adult should be about fourteen pounds. After the extension has been applied, a long splint (Liston's or Desault's) should be placed on the outer side of the limb and be fixed to the foot, and bandaged round the thigh and round the body. It should extend as high as the axilla. If there is much splintering of the great trochanter, a broad bandage, preferably of flannel, should be placed round the hips before the long splint is applied. These fractures unite soundly by bone. Where the fracture is impacted no attempt should be made to disengage the impaction; all that is required is to keep the limb quiet with a long splint, without extension. Union readily takes place, but with shortening and probably eversion.

c. **Separation of the great trochanter** has been described as occurring without any fracture of the shaft or neck of the bone. Probably, as most of the cases occurred in young persons, they were instances of disunion of the epiphysis, which is an injury that has been demonstrated by post-mortem examination. It is the result of direct violence, and the detached process is drawn upwards and backwards by the external rotators and the gluteus medius and minimus. The trochanter can be felt as a movable boss of bone in its new position, and by pushing it down crepitus can sometimes be felt. There is no shortening and no impairment of the movements of the hip joint. Usually there is considerable bruising and swelling from the direct violence. There is great difficulty in getting the fragment into its proper position and retaining it there. Attempts have been made to do this by means of compresses and bandages, but have not been successful, the patient recovering with permanent lameness. It would seem justifiable in these cases to resort to operation, and wire or peg the bone into position.

d. **Fracture through the great trochanter.**—This fracture was described by Sir Astley Cooper as 'oblique fracture through the trochanter major, without implicating the neck of the bone.' The fracture usually runs from the base of the lesser trochanter upwards and outwards to the base of the great trochanter, so that this process of bone, the neck, and the head, are separated from the shaft, and the fracture is entirely extra-capsular. The displacement is confined principally to the lower fragment, which is drawn upwards and backwards by the gluteus maximus and forms a prominence which can be felt on the buttock. The symptoms resemble those of extra-capsular fracture, but it can be differentiated from this injury by the presence of the prominence on the buttock, and by the fact that 'the upper part of the trochanter does not obey the motions of the lower and of the shaft of the bone' (Sir A. Cooper). The treatment is the same as that recommended for extra-capsular fracture.

e. **Separation of the epiphysis of the head of the femur** is said to occur in rare instances, but the lesion has never, I believe, been verified by post-mortem examination. The symptoms are the same as those of fracture of the neck of the bone, but they occur in children, and the crepitus, if any exists, is of a soft character, and differs from the bony crepitus which would be present if fracture of the neck occurred in a young person.

2. **Fractures of the shaft of the femur.**—The shaft of the femur may be fractured at any part of its course, but most frequently somewhere near its centre, in the middle third. Fractures in the lower third, generally the result of direct violence, are more common than fractures in the upper third, which are almost always produced by indirect force. Fractures in the middle third may be either caused by direct or indirect violence, or by muscular action. The fracture may be oblique, transverse, longitudinal, or spiral. The oblique is the most common, and is the result of indirect violence. The transverse most frequently occurs in children. The displacement which takes place depends to a great extent on the direction of the line of the fracture; but for the most part the lower fragment is displaced behind the upper and is drawn upwards by the hamstring muscles, so that there is considerable shortening. In the upper third of the bone the upper fragment is drawn forwards by the ilio-psoas and rotated outwards by the external rotators, and the lower fragment is drawn upwards by the hamstring muscles behind the upper.

and is drawn inwards by the adductors and rotated outwards by the weight of the limb, possibly assisted by the adductors (fig. 153). In the middle third the displacement is much the same, but the upper fragment is drawn inwards by the adductor brevis and longus. In the lower third the upper fragment is also drawn inwards by the adductors, while the lower fragment, especially if the fracture is near the condyles, is pulled backwards into the popliteal space by the gastrocnemius (fig. 154). Though these are the most common displacements, they are subject to considerable variations, depending, as has been said, upon the direction which the fracture takes. In children, where the fracture is transverse and the periosteum is not completely torn across, little or no displacement may take place.

Symptoms.—The signs of fracture of the shaft of the femur are usually well marked. Upon examining a patient it will be at once seen that the thigh is shortened, and rests on its outer side on the bed, with the leg slightly flexed on the thigh, and the thigh on the pelvis. Any attempt to move the limb will cause pain, and a solution of continuity in the bone will be at once detected. Crepitus can readily be elicited. If there is much displacement, the fragments can generally be felt under the skin.

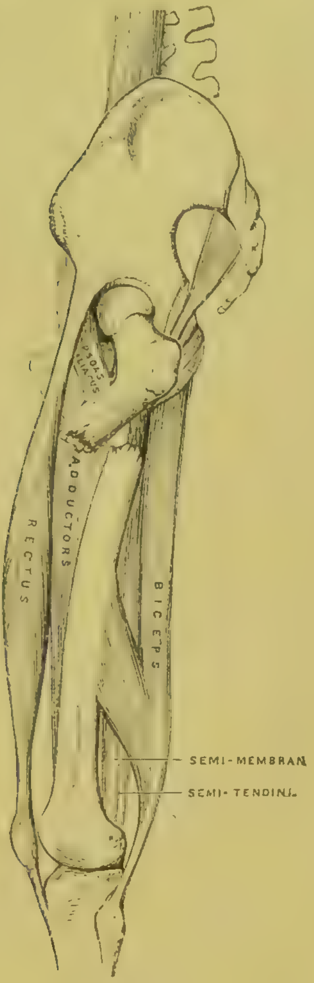

FIG. 153.—Fracture of the shaft of the femur below the trochanters, showing the displacement and the muscles by which it is caused. (From Gray's 'Anatomy.')

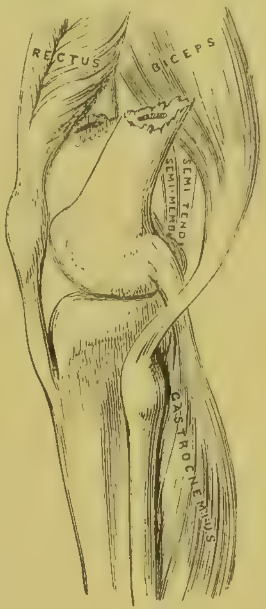

FIG. 154.—Fracture of the femur above the condyles, showing the displacement and the muscles by which it is caused. (From Gray's 'Anatomy.')

Treatment.—There is probably no form of fracture for which so many different kinds of appliance have at various times been recommended as fracture of the shaft of the femur. The two principal of these are the long splint and the double inclined plane.

The *long splint* consists of a piece of wood some four inches wide, which is applied to the outer side of the body from just below the axilla to the foot, where it terminates in a foot-piece (Desault's splint); or to some five or six inches below the foot, when its extremity presents two notches (Liston's splint). The upper end of Desault's splint is notched; the upper end of Liston's splint has two perforations. By some surgeons this is the only splint used; others in addition use three short thigh splints, one in front, one behind, and one on the inner side. There are various ways of applying the long splint. Most surgeons consider that some means by which continuous extension can be kept up is necessary: for my own part, for some years I have dispensed with this, and have seen no reason to regret it. The manner in which I use the long splint is as follows: the form of splint used is Desault's, which in my opinion is preferable to Liston's, as the foot-piece serves to prevent the tendency there is for the limb to roll outwards. The splint is placed on the outer side of the body, and the foot firmly bandaged to the foot-piece by a figure-of-8 bandage, a pad having been first placed over the back of the heel and tendo Achillis, and a second over the dorsum of the foot. When this has been done, three short splints, cut obliquely above, should be adapted to the thigh, and loosely buckled in position by two broad webbings, one placed as high as the perineum will allow, the other at the level of the upper border of the patella. The short splints are placed in front, behind, and on the inner side of the thigh, in such a manner that the highest point of the oblique border points to the anterior superior spinous process of the ilium. Below, the splints should extend to the level of the knee joint, or a little beyond it. As soon as everything is in position an assistant grasps the foot and foot-piece of the splint, and by a steady pull makes extension until the deformity is reduced, and the limb is the same length as the opposite one; the webbings are then tightened and buckled. The final stage of the proceeding consists in fixing the upper part of the splint to the body. In order to do this a piece of stout calico some two feet in breadth is sewn to the outer side of the splint, and is then carried underneath the patient, round the sound side of his trunk, and back again to the splint, to which it is firmly attached. This prevents the splint from being displaced forwards, an accident which is likely to happen if the trunk and splint are simply encircled by a rib roller. It will be found that if this plan is adopted there will be no tendency to a recurrence of the displacement, and the patient will recover with as little shortening as if continuous extension had been kept up. If the fracture is in the upper third of the femur, it is a wise precaution to supplement this treatment by applying a spica bandage to the hip over the top of the splints.

Most surgeons, however, prefer to employ extension, and there are two principal ways of doing this. (1) One method is by means of a weight and pulley fixed to the end of the bed, and connected with a stirrup of strapping attached to the lower third of the thigh; counter extension being made by raising the foot of the bed. This is put on before the long splint is applied. (2) The other method is by the employment of a perineal band, which in my opinion is absolutely useless, for it must either be drawn so tightly that it is sure to gall the patient, or if this is not done it will be so loose that it will be perfectly inefficient. It consists of a padded strap which is passed round the inner side of the upper part of the thigh, one end being brought up in front, and the other behind. After the foot has been fixed to the splint, and extension made to reduce the displacement, these two ends are fixed over the notch in Desault's splint, or through the holes in Liston's splint, and thus the perineal band is intended to act as a counter extension. Other plans of extension which have been employed are by means of elastic accumulators adapted in various ways. Mr. Bryant recommends a double long splint, one on either side of the body, the two being connected by crossbars, one over the chest, another below the feet, and states that it is more comfortable, absolutely immobilises the limb, and maintains parallelism of the two extremities. Extension is made with this splint by an elastic accumulator.

The *double inclined plane*.—This mode of treating fractures of the femur was formerly much in vogue, but has now to a great extent fallen into disuse, though it is still usefully employed in fractures near the hip and knee joints, where there is great deformity. The rationale of this plan of treatment is by flexing the thigh on the pelvis, and the leg on the thigh, to relax the muscles which are principally concerned in bringing about the deformity. There are several different ways in which this may be done. Both limbs may be flexed on a special bedstead known as Earle's bedstead, or a framework of wood may be readily constructed, as in fig. 155, or an ordinary MacIntyre's splint may be bent to the proper angle. But the most convenient mode of applying the double incline is by the splint of Nathan Smith or of Hodgen. Dr. Nathan Smith's splint consists of a framework of stout wire, bent in such a way that when it is applied to the limb the leg is flexed on the thigh, and the thigh on the pelvis (fig. 156). The splint is applied to the front of the thigh, leg, and dorsum of the foot, and securely fixed by bandages or strapping, and is then suspended by two hooks, inserted into it, to the ceiling, or a bar fixed over the patient's bed. Hodgen's splint is very similar; but instead of the limb being bandaged to the splint, it is supported on a cotton sacking fixed to the framework. The double inclined plane should be reserved for those cases (1) of fracture of the femur high up, when the upper fragment is tilted forwards, forming a projection under the skin, and is too short to be controlled by the ordinary splints, and (2) fractures of the lower end of the femur, when the lower fragment is flexed on the tibia by the action of the gastrocnemius, and its upper end projects under the skin in the popliteal space. Another way in which the same end as that desired to be gained by the double inclined plane may be obtained is by laying the limb on its outer side, with the thigh and leg flexed, and fixing it in this position. Some surgeons recommend putting up fractures of the thigh in an immovable apparatus almost from the first, and allowing the patient to get up and go about on crutches, but the ordinary custom is to confine the patient to bed

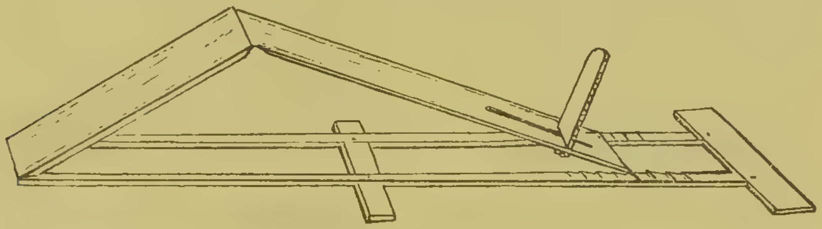

FIG. 155.—Double inclined plane, for the treatment of some fractures of the femur.

for three or four weeks, until a certain amount of union has taken place, and then put the limb up in the immovable apparatus. Union is generally fairly firm by the end of the eighth week, but the patient should not be allowed to bear the weight of his body on the limb without any support for twelve weeks after the accident. In children, union takes place much more quickly, and is generally quite firm in from six to eight weeks. In treating fractures of the femur in children, the plan advocated by Mr. Bryant should always be adopted. The ordinary forms of splints are constantly getting soiled by the urine and fæces, and require renewal. Mr. Bryant therefore recommends that these cases should be treated by vertical suspension. Extension stirrups having been applied, both limbs should be flexed at the hip, and the stirrups fixed to a bar over the child's bed, so that the sacrum barely touches the bed (fig. 157). In children, fractures of the thigh usually unite without any shortening, but in the adult shortening to a slight extent is a very frequent result of oblique fracture of the thigh by whatever means it is treated. When, however, this shortening does not exceed half an inch, it is a matter of comparatively little importance, since it is corrected by a slight inclination of the pelvis, and the patient walks without limping.

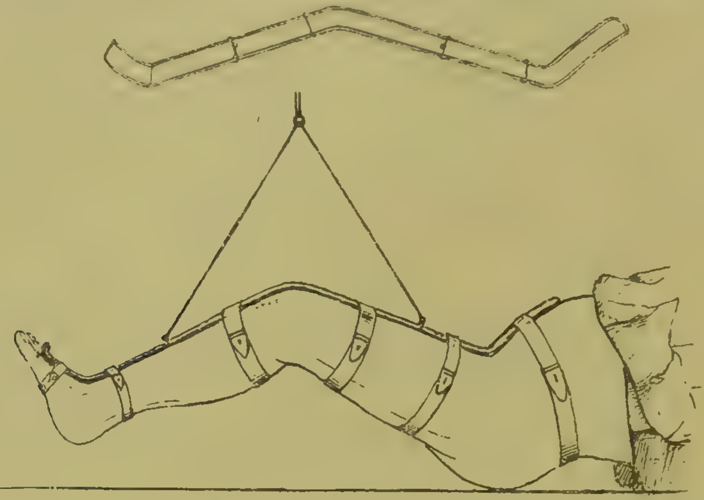

FIG. 156.—Nathan Smith's splint for the treatment of fractures of the femur.

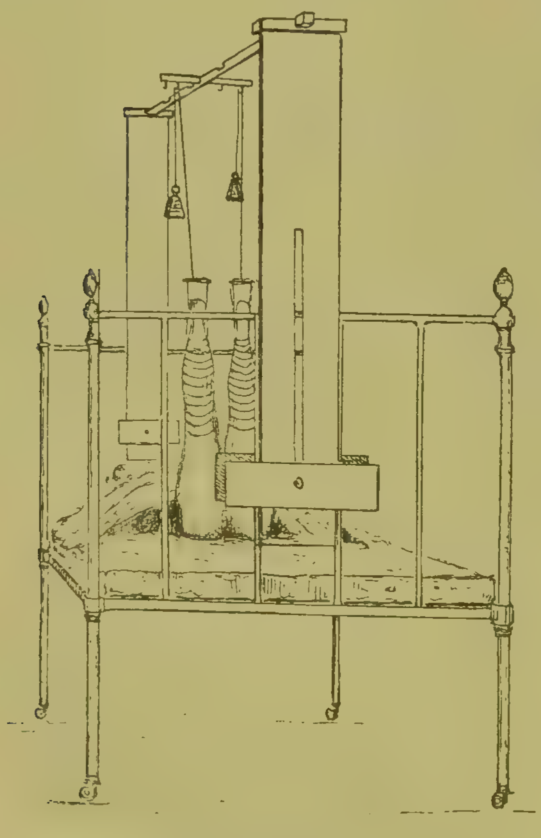

FIG. 157.
Treatment of fractured thigh by suspension.

3. **Fractures of the lower extremity of the femur** are almost always the result of direct violence, and very much resemble in their direction the fractures described as occurring in the lower extremity of the humerus. They may be: (*a*) Transverse fracture above the condyles (supra-condyloid); (*b*) T-shaped fracture; (*c*) oblique fracture through either condyle; (*d*) longitudinal or spiral fracture; (*e*) separation of the epiphysis.

a. **Transverse fracture above the condyles.**—This fracture very much resembles fracture in the lower third of the shaft of the bone, already described. The displacement is the same, the lower fragment being flexed on the tibia by the action of the gastrocnemius, and being drawn upwards by the rectus in front and the hamstrings behind. There is considerable shortening, and the lower end of the upper fragment can be felt prominently in front of the thigh and the lower fragment in the popliteal space. The femoral artery, as it becomes popliteal, is in danger of being injured in this fracture, or the popliteal artery may be pressed upon by the lower fragment, and the circulation of blood through it interfered with.

b. The **T-shaped fracture** is where there is a transverse fracture above the condyles and a vertical one between them. Occasionally the fracture may be more V-shaped, two oblique fissures running from the inter-condyloid notch, the one upwards and outwards, the other upwards and inwards. The symptoms of these fractures resemble the supra-condyloid fracture, but there is increased breadth between the condyles, and the joint will be full of fluid.

The **treatment** of these fractures is best conducted by means of the double inclined plane, but they may also be treated by extension with the long splint, if the tendo Achillis is first subcutaneously divided, so as to paralyse the action of the gastrocnemius.

c. **Oblique fracture,** separating one or the other condyle. In these cases there is no shortening, but the condyle is displaced upwards and the leg deflected to the injured side. The fragment can be felt to be displaced, can be moved from side to side, and crepitus is easily felt. The joint is distended with fluid.

Treatment.—When the limb is straightened, the fragment is drawn downwards into position, and the retention of the limb on a straight splint will retain it there.

d. **Longitudinal** or **spiral fissures** of the lower end of the femur, running upwards from the joint, may be produced by falls on the feet or knees. There is usually little or no displacement, but there is effusion of blood into the joint, and pain is complained of. Sometimes a grating may be felt upon moving the patella from side to side over the fractured surface.

In all these fractures, especially those which implicate the joint, there is a great probability of stiffness resulting; treatment by massage and early passive motion is especially indicated.

e. **Separation of the lower epiphysis** of the femur. This is not an uncommon accident in young people. The symptoms are much the same as those of transverse fracture of the lower end of the bone, except that the crepitus is less distinct or absent. They are to be treated in the same way as this fracture.

FRACTURE OF THE PATELLA

Fracture of the patella is a common injury, and the bone may be broken in two distinct ways—by muscular action or by direct violence. As these two forms of fracture differ materially in many particulars, it is necessary to consider them separately.

Fracture from muscular action.—This is the more common mode in which fracture of the patella is produced. The way in which it occurs is somewhat peculiar, as it always takes place while the leg is in a position of semiflexion. When this is so the patella rests on the front of the condyles of the femûr, and if at this moment any sudden contraction of the quadriceps extensor takes place the bone is snapped across, much in the same way as a piece of stick may be broken across the knee. The fracture is therefore always transverse; almost always, if not always, complete; and the fibrous structures which cover it in front and the cartilage on its articular surface are also torn. The fibrous capsule on either side of the patella is also torn, and there is therefore great displacement, the upper fragment being drawn upwards by the quadriceps extensor (fig. 158), and retained by the effusion which takes place into the joint, first of blood and subsequently of inflammatory exudation. The fracture generally takes place somewhere near the middle of the bone, but sometimes one fragment is much bigger than the other.

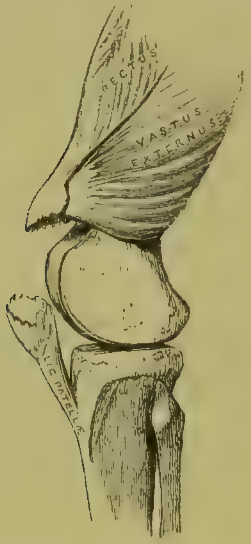

FIG. 158.—Transverse fracture of the patella, showing the displacement caused by the quadriceps extensor cruris. (From Gray's 'Anatomy.')

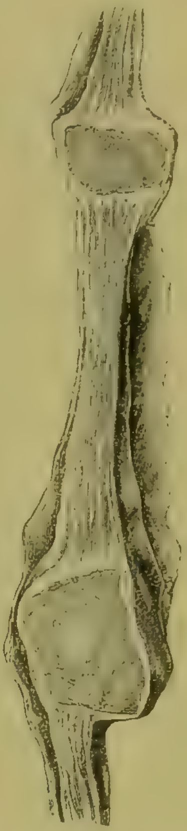

FIG. 159.—A transverse fracture of the patella, united by fibrous tissue, with great separation of the fragments. (From 'A System of Surgery,' by Holmes and Hulke.)

The **signs** of this fracture are well marked. There is the history of a sudden slip and an effort to recover the equilibrium—the manner in which this accident usually takes place—and there is loss of power in the limb. The separation of the fragments will be readily detected, and if the patient is seen before the joint becomes filled with fluid a distinct depression will be visible where the prominence of the patella normally exists. If, however, the patient is not seen for some little time, there will be found to be great swelling from effusion into the joint. This consists at first of blood and subsequently of altered synovial fluid, the result of inflammatory changes in the synovial membrane. The separation of the fragments will be found to be increased on bending the knee. Generally there is no crepitus, but where the effusion into the knee is not great the upper fragment may be pushed down to the lower, and then crepitus will be elicited.

The **mode of union** in transverse fracture produced by muscular action is probably always by fibrous tissue, and this is due to two factors: firstly, the impossibility of keeping the fractured ends of bone absolutely in contact; and secondly, because the fibrous structures over the bone are irregularly torn and shreds of tissue become interposed between the fractured ends. In many cases the fibrous aponeurosis is torn at a different level to the fracture, and the end becomes tucked in between the broken surfaces. This fibrous union is at first very pliable and extensible, but becomes firmer and more resisting after a time (fig. 159). So that if care is taken not to allow the patient to bend the knee and so stretch this fibrous union until it has become firm and resisting, a very perfect result may be obtained, and the result is as good, as regards the patient's powers of progression, as if bony union had taken place. But the process of consolidation of this fibrous union is a very slow one, and it is usually estimated that twelve months must elapse before the union can be regarded as quite inextensible, during the whole of which time the patient must go about in an apparatus which keeps the knee extended and fixed.

Treatment.—The treatment of fractured patella from muscular action is very various, and many plans have been and are adopted for its cure. During the last fifteen or twenty years it has materially altered, since the establishment of the antiseptic treatment of wounds. And I must confess that with increased knowledge of and confidence in antiseptic measures my own views of the proper treatment of these cases have considerably changed. There are two ways of treating transverse fracture of the patella—one by employing different forms of retentive apparatus, which aim at bringing the fragments into as close apposition as possible and retaining them there, and by this means securing a fibrous union; and the other by operative interference, in order to obtain bony union.

Treatment by retentive apparatus consists in the first instance in getting rid of the effusion into the joint, which prevents the fragments being approximated. This may be done by aspiration, and this is probably the best, as it certainly is the quickest way of doing this; by pressure from a Martin's bandage, or by the application of ice or evaporating lotions. This having been done, the fragments can be approximated, and may be retained in position by two pieces of strapping, placed one above and the other below the patella and crossed behind the joint. The limb may then be put up in an immovable apparatus of plaster of Paris or whatever material the surgeon prefers, or the limb may be put upon a single inclined plane, or a back splint with a foot-piece raised on pillows. Many other plans have been adopted to retain the fragments in apposition. Malgaigne's hooks were formerly much employed, but have now, I believe, fallen considerably into disuse. There are serious objections to their employment. The 'Middlesex plan' consists in applying a square piece of moleskin plaister to the lower part of the thigh, so that the lower border, in which a notch is cut to fit the upper fragment of the patella, shall press upon this piece of bone. India-rubber bands are then attached to the inferior angles of this border, and being put on the stretch are attached to the foot-piece of the splint on which the limb is placed. By their elastic tension they keep the fragments in position. A somewhat similar plan of bringing down and keeping in position the upper fragment by elastic tension is advocated by Manning. He fixes a piece of webbing to the back of the thigh by means of strips of strapping, which are made to encircle the thigh and are sewn to the webbing, the lowest strip being an inch or two from the patella. The webbing is then passed through a hole in the back splint, on which the limb is placed, about midway between the knee and ankle, and is fixed to the foot-piece by an elastic band.

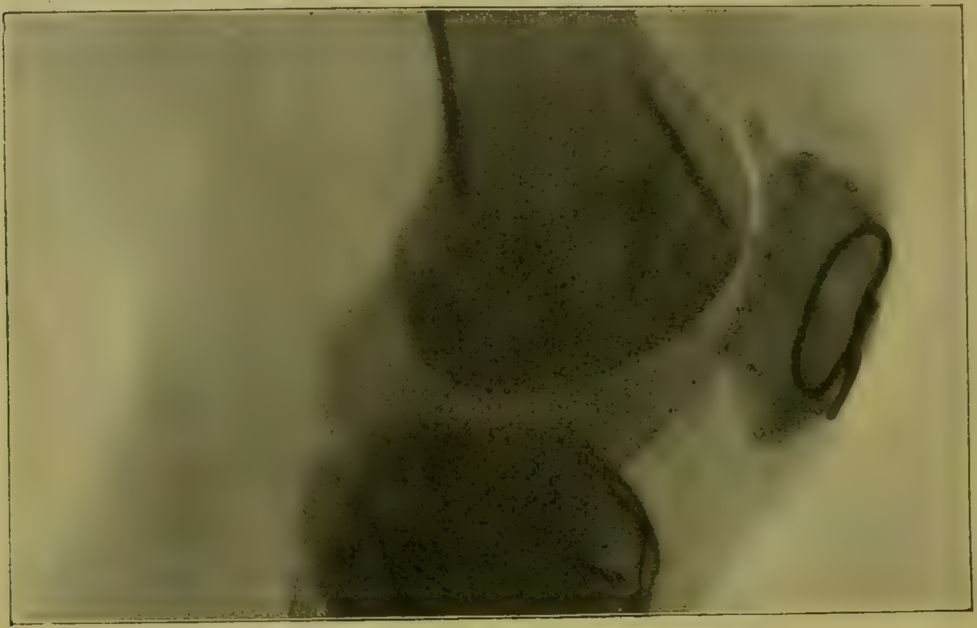

FIG. 160.—Skiagraph of a transverse fracture of the patella united by silver wire.

Treatment by operative interference may be considered under two heads: viz. firstly, treatment by exposing the fracture by an incision and wiring the ends together; and secondly, treatment by subcutaneously suturing the fractured bone.

The first or open plan of treatment consists in making a vertical or horseshoe-shaped incision over the patella and freely exposing the joint, removing all blood from its interior and any portions of ligamentous tissue from the fractured surfaces and then wiring them together with a stout silver wire (fig. 160). One wire is generally sufficient, but if there is any difficulty in obtaining accurate contact two should be used. Holes are first drilled in the bone from the anterior surface to emerge on the fractured surface close to the articular cartilage. Care must be taken in drilling these holes that they exactly correspond on the two surfaces, so that when the portions are brought together there shall be no unevenness of the articular surface. Along the tracks thus formed a stout silver wire is passed, the fractured surfaces are approximated, and while they are held in position the wire is drawn tight and twisted, cut off short and the ends pressed down into the anterior surface of the bone. The wound is then sutured and dressed and placed on a back splint. At the end of a week passive motion is commenced, the limb being retained on the splint during the intervals for three weeks. The patient may then be allowed to get up and go about on crutches, and at the end of six weeks bony union will probably have taken place, and the patient may put his foot to the ground.

In order to avoid an open wound many subcutaneous operations have been suggested. The first of these is Kocher's method. He passes a thick silver wire beneath the fragments, by introducing a strong curved needle on a handle with an eye at the point, through the skin and quadriceps extensor immediately above the patella, into the joint; he then carries it down behind the fractured bone and makes it emerge through the ligamentum patellæ and the skin immediately below the patella. He now threads it with the wire and withdraws it. Having approximated the fragments, he twists the ends of the wire together, protecting the skin over the patella with a pad of lint. A. E. Barker has slightly modified this operation, for after passing the silver wire very much in the manner described, he, by a reintroduction of the needle between the skin and the patella, brings the upper end of the wire down to the lower puncture, and twists the two ends together. He also makes a puncture into the joint with a scalpel immediately below the lower fragment, so as to evacuate as much of the blood as possible.

Mayo Robson aspirates the joint, then passes two stout needles transversely, one through the quadriceps extensor immediately above the upper fragment, the other through the ligamentum patellæ below the lower fragment. He then draws the needles together by elastic bands twisted over the ends of the needles on either side.

Twynam passes a silver wire subcutaneously around the two fragments, making the two ends emerge at the same opening. Having approximated the fragments, he twists the two ends tightly together.

Having thus briefly alluded to the principal modes of treating fracture of the patella, the question naturally suggests itself as to which is the best plan to pursue. And in answering this question the general condition and habits of the patient will have to be taken into consideration. If the patient is not advanced in life, is perfectly healthy, without any visceral disease, and is engaged in active manual work, the treatment by operation would appear to be the best, always provided that the operator is a surgeon who is accustomed to practise aseptic surgery and is thoroughly well drilled in its technique; but if, on the other hand, the patient is advanced in life, is debilitated by privation, by indulgence in excess of alcohol, or by disease of any of the internal organs, treatment by some form of retentive apparatus should be resorted to. The main reason for advocating operative interference is the length of time which the other plan of treatment requires to be carried out. We have seen that by various splints and contrivances very excellent results can be obtained, and this without the slightest danger to life or limb; but for this to be carried out effectually it is necessary to deprive the patient of the full use of his limb for twelve months, and this to a man in active manual work is a very serious matter. It seems, therefore, to be worth his while to run the risk of an operation in order to secure the advantage of a perfect recovery in six weeks, for in the hands of a surgeon thoroughly *au fait* in the details of antiseptic surgery the risk is not great. This being conceded, a second question then suggests itself: whether it is better to operate by the open method or by one of the subcutaneous methods mentioned above. I unhesitatingly answer—by the open method. The risk of the one operation is probably not greater than the other, certainly in the operations of Kocher and Barker, where the joint is opened and where the contained blood cannot be thoroughly got rid of, and the benefits to be derived are correspondingly great. The main objection to all these subcutaneous operations is that the fractured surfaces cannot be freed of any overhanging pieces of aponeurotic tissue, the presence of which is one of the main causes of failure in obtaining bony union.

In the open method the joint can be thoroughly cleared of all blood clot, the fragments can be accurately adapted, and without the presence of any foreign body between the fractured ends, a perfect bony union is the result.

Fracture of the patella from direct violence.—These fractures differ from the preceding in many essential particulars. As a rule they are stellate, but they may be oblique, longitudinal, or even transverse. They are often incomplete, that is to say, they do not penetrate the whole thickness of the bone, and therefore do not open the joint. In some cases also the fibrous expansion over the patella is not torn, nor the capsule of the joint on either side, and there is therefore generally very little displacement. The symptoms are the history of a fall or blow on the knee; the presence of considerable bruising and ecchymosis; inability to move the joint without great pain; perhaps crepitus, and possibly some effusion in the joint. These fractures unite readily by bone. The treatment consists in keeping the limb quiet on a back splint in an extended position and applying some evaporating lotion. If the fragments should be widely separated, some form of the retentive apparatus mentioned above should be employed. These cases are not so suitable for operation, on account of the bruising of the soft parts.

FRACTURE OF THE BONES OF THE LEG

In **fractures of the leg** both bones are usually broken, although each bone may be broken separately.

Fracture of the tibia.—When the tibia is fractured alone, it is generally the result of direct violence. If the fracture takes place at the upper part it is usually transverse, though some few cases of longitudinal splitting have been recorded; when the fracture is in the lower half of the bone it is generally oblique. In the transverse fracture there is, as a rule, very little displacement, and the symptoms are not very obvious, and even in the oblique fracture the displacement is not great, as the fibula acts as a splint. In most instances some irregularity in the outline can be felt by running the finger down the subcutaneous surface; and by grasping the bone above and below the painful spot and moving it crepitus can be elicited. There is usually considerable bruising and swelling.

The internal malleolus is sometimes broken by direct violence, without any other bone being broken. There is no great displacement, but the presence of the fracture can be at once ascertained by grasping the process, when it will be found to move backwards and forwards under the pressure of the finger and thumb, and perhaps crepitus may be felt. The injury is of importance as it is liable to lead to permanent lameness, as a certain amount of lateral movement is often permitted in the astragalus from faulty union of the process, so that this bone is not tightly gripped between the two malleoli.

The **treatment** of all these fractures is the same. They should be put up in side and back splints until all swelling has subsided, and then be encased in some immovable apparatus and the patient allowed to get up.

Fracture of the fibula.—The upper two-thirds of the fibula is seldom fractured; when it is, the fracture is produced by direct violence. There is often no displacement, and the bone being surrounded by a mass of muscles, the diagnosis is often difficult. There is a fixed pain, increased on movement, with possibly crepitus. A linear ecchymosis appearing over the site of the fracture some few days after the accident is characteristic of the injury. When fracture occurs in the lower third of the bone, it is generally the result of indirect violence, and may be caused by twisting the foot either inwards or outwards. These fractures are more easily diagnosed than those higher up, because any irregularity of the bone can more readily be detected. There is pain, increased by pressing on the part or by moving the bone, and generally crepitus can be elicited.

Treatment.—If there is no swelling or bruising these fractures may at once be put up in an immovable apparatus and the patient allowed to go about on crutches. If there is swelling it is better to confine the limb in a roll-junk for a few days until it has subsided and then put it up.

Fracture of both bones of the leg is a very common injury, and may be produced either by direct or indirect violence. When caused by direct violence, the fracture may be at any part and is generally transverse; when caused by indirect violence, the tibia first gives way at its weakest part, the junction of the middle and lower third, and then the fibula at its weakest part, on a higher level than the fracture in the tibia. These fractures are oblique in direction and most usually run downwards, forwards and inwards, but may vary in this respect according to the direction in which the force was applied. The displacement in the transverse fracture, especially when it occurs high up, is usually not great, but in the oblique fracture there is often very considerable displacement, and the direction in which it takes place depends to a great extent on the direction of the line of fracture. In the more common fracture, where the line runs downwards, forwards and inwards, the lower fragment is drawn upwards, backwards and outwards, behind the upper, by the muscles of the calf, while the sharp end of the upper fragment projects under the skin in front and often perforates it, producing a compound fracture (fig. 161). When the line of fracture is in the opposite direction, the lower fragment is displaced in front of the upper, but is still drawn upwards by the calf muscles. In both fractures the lower fragment is rotated outwards by the weight of the foot.

The **diagnosis** of these fractures can be easily made, since the irregularity in the outline of the bones can at once be detected by running the finger down the subcutaneous surface of the tibia, and combined with this are the ordinary signs of fracture.

Treatment.—The deformity is first to be reduced by flexing the leg on the thigh and having it held in this position by an assistant, so that the muscles of the calf may be relaxed, and making traction from the foot and manipulating the bones into position. The apparatus for maintaining the bones in apposition are very numerous. The plan most commonly adopted, and probably the most efficient, is to put the leg up in a straight back splint, with a foot-piece for the sole at right angles to it, and two side splints. Great care must be exercised in adjusting these splints to see that the length of the limb is preserved and no rotation of the lower fragments permitted. The foot should be kept at right angles with the leg, and the proper line of the limb preserved. That this is so may be known by noting that the inner border of the patella, the internal malleolus, and the inner side of the ball of the great toe are in the same line. The patient is kept in bed in these splints until all swelling and œdema have disappeared, generally for about three weeks, and the limb is then put up in plaster of Paris splint or some other immovable apparatus, and the patient allowed to go about on crutches.

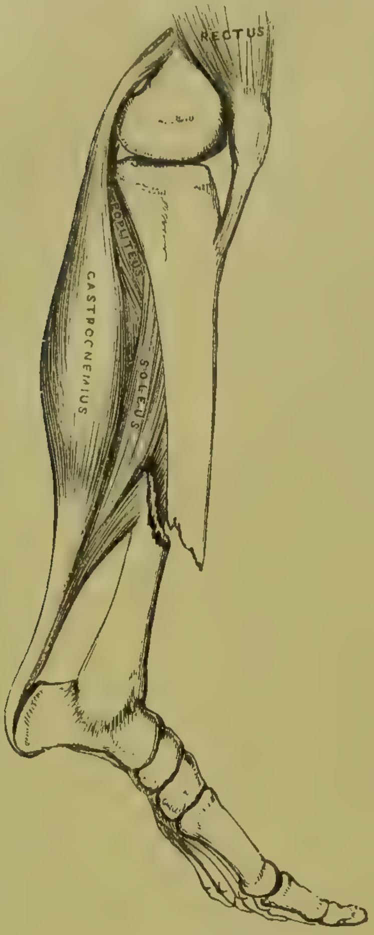

FIG. 161.—Fracture of the bones of the leg, showing the displacement and the muscles by which it is caused. (From Gray's 'Anatomy.')

Fracture of the tibia and fibula near the ankle joint.—This is a common and serious lesion, and is accompanied by displacement of the articular surfaces of the ankle joint. It is produced by severe strains or twists of the foot, as when a patient falls with his foot bent under him. The displacement may take place either outwards or inwards, the former being much the more common of the two.

In **displacement outwards** the fibula is broken by the astragalus being pushed violently against the external malleolus; this tends to push this portion of bone outwards, and the strain is thrown upon the lower end of the fibula, at its weakest part, about three or four inches from the end of the bone, and it gives way in this situation (fig. 162, A). The force being continued, the strain on the internal lateral ligament causes this structure to give way, or the internal malleolus, to which it is attached, to fracture, and the tarsus is displaced outwards (fig. 162, C). This injury is known as *Pott's fracture*. If the force applied is greater the interosseous tibio-fibular ligament may give way, or the surface of the tibia, to which it is attached, may be torn off; there is then a separation of the lower end of the fibula from the tibia, and this portion of bone with the tarsus is displaced *upwards* and outwards, and there is a greater degree of deformity than in Pott's fracture. This lesion is known as *Dupuytren's fracture* (fig. 162, D). Finally, in some rare instances, where the force of the injury is excessive, instead of the internal lateral ligament being ruptured or the internal malleolus torn off, there is a transverse fracture of the lower end of the tibia, just above the articular surface, and then the lower fragment of the tibia, the lower end of the fibula and the foot, are all displaced outwards and upwards. In these cases the lower end of the upper fragment of the tibia projects under the skin, and may sometimes perforate it, forming a compound fracture (fig. 162, B).

In these fractures the displacement of the tissues at the ankle joint is

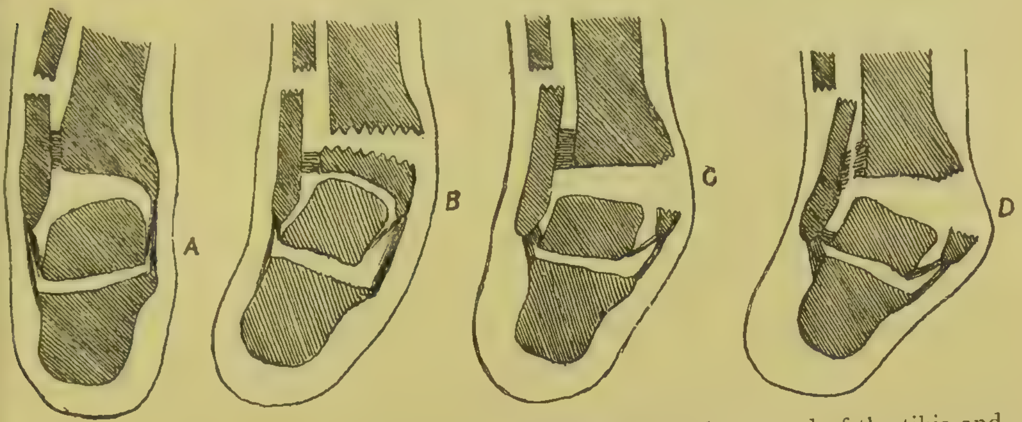

FIG. 162.—Diagram showing the fractures which occur at the lower end of the tibia and fibula. A, displacement in fracture of fibula. B, displacement in fracture of the lower end of the tibia. C, displacement in Pott's fracture. D, displacement in Dupuytren's fracture.

a somewhat peculiar one. In Pott's fracture, for instance, the dislocation is not a true lateral displacement outwards, but the astragalus undergoes a partial rotation on an antero-posterior axis through its centre, so that its upper articular surface is inclined inwards and the sole of the foot everted (fig. 162, B, C, and D).

The **signs** of these injuries are unmistakable; the foot is markedly everted, and in Dupuytren's fracture is carried upwards as well; there is a hollow over the fracture of the fibula and the internal malleolus, or its broken surface projects strongly under the skin. In addition to this there is great swelling and bruising, and crepitus will usually be felt on overcoming the displacement. Care must be observed not to mistake an ordinary Pott's fracture for those cases where the lower end of the shaft of the tibia is broken. In the latter the displacement is greater, the crepitus is more marked, and the prominent end of the upper fragment is above the level of the ankle joint.

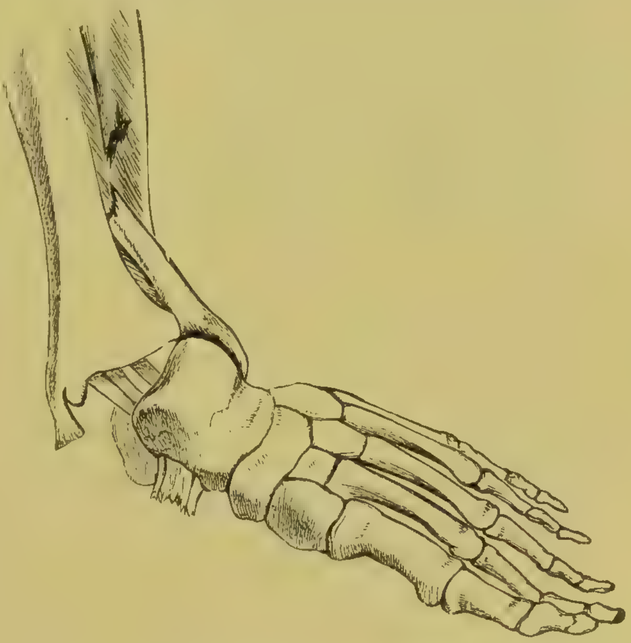

FIG. 163.—Displacement in Pott's fracture. In this case the deltoid ligament is ruptured. (From Gray's 'Anatomy.')

In **displacement inwards** the patient slips on the outer aspect of the foot, and it is forcibly inverted or turned inwards, carrying with it the external malleolus; this causes a fracture of the fibula at its weakest part, and the fragments, especially the lower, have a tendency to be displaced outwards. The foot at the same time is displaced inwards.

Treatment.—The first thing is to reduce the deformity. This can generally be done by flexing the leg on the thigh, in which position it is held by an assistant, and making traction from the foot. If the deformity cannot be reduced in this way, it is better in the first place to administer an anæsthetic and try again, care being taken during the administration of the anæsthetic to prevent the patient doing any injury to his limb by his movements. In the event of there still being difficulty in overcoming the displacement, subcutaneous division of the tendo Achillis must be resorted to. As these are cases in which the treatment by massage and early passive movements are especially called for, the best plan of maintaining the parts in position is to place the limb on a back splint with a foot-piece, from which it need not be raised during the first week or ten days while massage is being applied to the front and sides of the limb. Between the sittings the limb is secured to the splints by bandages round the foot and at the knee, and for extra security two side splints are applied. Care must be taken in these cases not to displace the fragments during the necessary exposure for the daily massage. At the end of a week or ten days the limb may be raised gently and carefully from the back splint, and passive movements of the ankle joint begun.

Two special methods have been recommended for the treatment of these fractures, to which, perhaps, it is well that some allusion should be made, though personally I have never seen a case which required any special treatment. 1. **Pott's method.**—The patient is placed on his injured side, with the knee bent and the foot inverted. A short inside splint, reaching to the base of the internal malleolus, and an ordinary outside side splint, with the foot more thickly padded than the rest of the splint, are now applied. The thick padding turns the foot inwards. 2. **Dupuytren's method.**—A straight splint, reaching some inches below the foot, is applied to the inner side of the leg, with a wedge-shaped pad, broad end downwards, corresponding to the base of the internal malleolus, between the limb and the splint. The upper part of the leg and the foot are bandaged to the splint, and thus the foot is drawn inwards.

Fracture of the bones of the tarsus.—The calcaneum may be broken by direct violence or by muscular action. The fracture usually takes place in the posterior half of the bone, and the detached fragment is drawn upwards by the muscles of the calf, and the deformity produced is evident. Where there is no displacement, crepitus can usually be felt, and there is much swelling and bruising. In the **treatment** of fracture of the calcaneum without displacement all that is necessary is to immobilise the part by means of an outside splint, the limb resting on the splint, and to apply an evaporating lotion. If there is displacement, the leg must be flexed on the thigh, and the foot extended on the leg and fixed by a leather collar fastened round the lower third of the thigh and attached by a string to the heel of a slipper, the limb being laid on its outer side on a pillow. There is nothing special to be said about the fractures of the other tarsal bones. They are produced by direct violence, and are usually accompanied by much bruising and swelling. They are frequently difficult to diagnose, but crepitus may generally be elicited by moving the bones on one another. Rest, with the foot and leg on a splint, and the application of lotion or ice, is all that is necessary.

Fracture of the metatarsal bones and phalanges is almost always produced by direct violence; very often by severe crushing force, which produces such laceration as to necessitate amputation. When a single bone is broken there may not be much displacement, but when two or three are broken there is often considerable deformity. When no displacement exists all that is required is to place the foot on a light splint and keep it quiet; if displacement exists it must be remedied by extension and manipulation, otherwise the bones will unite in a faulty position and be the source of much discomfort and annoyance to the patient.

DISEASES OF BONES

Bone consists essentially of ordinary connective tissue. This connective tissue is arranged differently in different parts. On the surface of the bone it is arranged as a membrane, the periosteum, which supplies nourishment to the bone and in early life assists in its formation and growth; in the bone proper it is for the most part impregnated with earthy salts, but a certain amount of connective tissue remains unimpregnated in the Haversian canals, and is directly continuous with the periosteum on the one hand, and with the connective tissue filling the central canal on the other. This latter tissue consists of a vascular medulla, serving not only to supply nutrition to the bone, but also probably assisting in elaborating the blood.

In **inflammation of bone** it is this connective tissue which is the seat of the process, and the same changes take place in it as occur in inflammation of other structures. The inflammation may commence in any of the parts above mentioned—the periosteum, the bone proper, or the medullary tissue, and hence we have periostitis, ostitis, and endostitis or osteo-myelitis. In all, however, the inflammation owes its existence and continuance to the connective tissue, whether covering the surface of the bone as periosteum, or carried along with the vessels in the Haversian systems, or massed together in the central canal of the bone. In consequence of the intimate connection which there is between these different parts of the same structure, inflammation in one very quickly extends to another, and we cannot long have inflammation of one without the others becoming affected; and ostitis, periostitis, and endostitis are soon all present in the same case.

For the convenience of description it is necessary to describe these three conditions separately from each other, but the student must bear in mind that though these three diseases are described as distinct conditions, he will rarely, hereafter, in practice find the one condition without one or both of the others being present.

PERIOSTITIS

Inflammation of the periosteum may be either local or diffuse. The local form may be either acute or chronic.

Acute local or simple periostitis is when inflammation attacks a limited area of periosteum and shows no tendency to spread beyond it. It is most usually the result of an injury, as a blow, but may also be set up by an extension of inflammation from surrounding parts, as, for example, a periostitis of the jaw set up by an alveolar abscess. It is also the result of constitutional conditions, as syphilis and tuberculosis, in which a small localised periostitis, which is often acute, may be set up. The localised swelling which is formed is termed a **node**. The same condition may follow acute rheumatism, typhoid fever, scarlet fever, and measles.

Pathology.—The periosteum becomes swollen and red and infiltrated with inflammatory products, which accumulate principally in the deeper layer and between it and the bone, so that the membrane strips easily from the bone. The inflammation may terminate in resolution, or it may pass on into suppuration, but most commonly it becomes chronic and ends in the formation of new bone—osteo-plastic periostitis—which is simply an increase in the normal function of the part, resulting from a morbid increase in its functional activity.

Symptoms.—If the disease is situated on a subcutaneous portion of bone, as it most frequently is, there is a defined swelling, fixed to the bone: it is hard and tense, acutely painful, the pain being increased by pressure and worse at night. If suppuration occurs the pain becomes intensified, the swelling increases and becomes softer in the centre, and the skin over it becomes red and œdematous. In the osteo-plastic form the swelling remains hard and unyielding, and the pain assumes an intermittent character, being especially severe at night and when the limb is maintained in a dependent position.

The **treatment** consists in keeping the part at rest and the limb elevated. In the early stage the application of a couple of leeches will very often materially relieve the pain. This should be followed by the application of hot fomentations and the administration of a brisk purge. If the disease does not yield to treatment, and suppuration threatens, a free incision should be made down to the bone through the inflamed periosteum. If this is not done early after the commencement of suppuration, the underlying bone will in all probability die, and must either be absorbed or exfoliate, and thus a discharging sinus will be left for some long period of time. In those cases where the disease assumes a chronic form and tends to be osteo-plastic, the treatment should consist in the repeated application of flying blisters, or oleate of mercury ointment, and the internal administration of iodide of potassium.

Chronic periostitis is most intimately associated with chronic ostitis, and cannot be differentiated clinically from it. It may occur either as the sequel of the acute form of the disease, or it may assume a chronic form from its commencement. It is most frequently under these circumstances due to syphilis, but may also occur in the rheumatic or tuberculous subject. The symptoms consist in a hard elongated swelling, involving one aspect of a bone, and this is generally the subcutaneous surface of those bones which are situated just under the skin. The great characteristic is the dull, aching, gnawing pain at night; as soon as the patient gets warm in bed, the bone begins to ache, preventing him from sleeping. The inflammatory effusion into and under the periosteum gradually undergoes conversion into bone, so that chronic periostitis is almost always of the osteo-plastic variety (fig. 164).

Treatment.—This consists in the long-continued administration of iodide of potassium, which in those cases that are syphilitic in their origin almost always relieves the pain and arrests the disease. This may be supplemented by repeated blistering, and where the pain is very severe, and relief from the administration of iodide of potassium not obtained, by a linear section through the periosteum down to the bone.

Acute diffuse periostitis is an infective inflammation, which is now usually known under the name of *panostitis* or *acute necrosis*; the former because all the tissues of the bone, periosteum, endosteum, and bone proper, speedily become involved in the disease; and the latter because, whether originating in the periosteum, or in the medullary tissue, as it sometimes does, it always terminates in rapid necrosis of the whole of the part inflamed. When the disease begins, as it undoubtedly does in many cases, in the periosteum, it is characterised by a rapidly spreading infiltration of this membrane with inflammatory exudation, which speedily ends in suppuration, and is accompanied by acute septicæmia. The disease is not, however, confined to the periosteum, but speedily extends along the connective tissue in the Haversian systems to the medullary tissue. Here the same spreading septic inflammation is set up, and runs on to suppuration. The portion of bone involved is thus deprived of all nutritive supply, and death takes place.

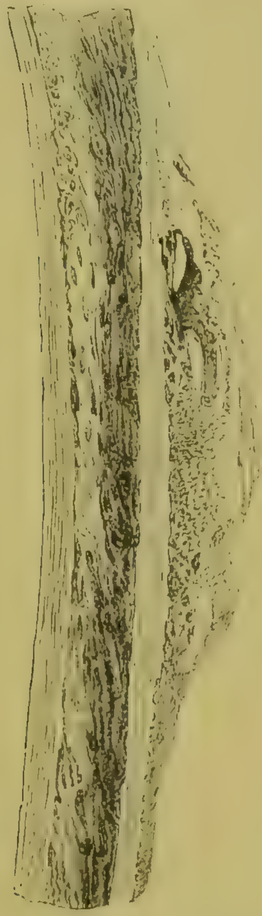

FIG. 164.—Osteo-plastic periostitis. (From 'A System of Surgery,' by Holmes and Hulke.)

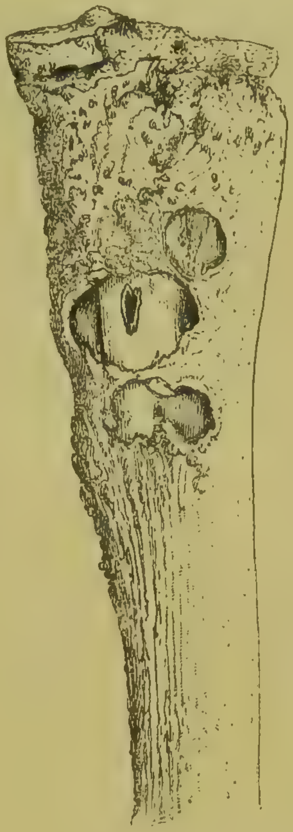

FIG. 165.—Necrosis after acute infective periostitis, showing a sequestrum, consisting of the shaft of the bone inclosed in an invaginating sheath of new bone formed from the periosteum. (From the Museum of St. George's Hospital.)

Pathology.—The disease is one of acute infective suppuration, due to the introduction of some of the pyogenic organisms, of which the Staphylococcus pyogenes aureus appears to be the most common. In the majority of cases it begins in the diaphysis of the bone in the neighbourhood of the epiphysial cartilage. The mode of entrance of the micro-organism into the body is unknown, but there is in a large number of these cases an antecedent history of some injury to the part some days previously, which would make it appear that some damage to the tissues is a constant means of providing a suitable nidus in which the microbes may multiply, and that if this nidus is not present the organism is incapable of exerting its evil influence. It commences as an effusion beneath the periosteum, which rapidly goes on to suppuration. The pus spreads far and wide, separating the periosteum from the bone, and may spread from one end of the shaft of the bone to the other, and completely around it, so that the whole diaphysis is denuded of periosteum. When it reaches the epiphysis it usually spreads along the epiphysial line, so that the epiphysis becomes separated from the diaphysis. Sometimes it spreads up the epiphysis to the neighbouring joint, which becomes filled with pus. Coincidently with this an extensive suppurative osteomyelitis takes place, and thus the whole shaft of the bone perishes. In other cases the ravages are not so extensive, and only a part of the shaft perishes ; in some a mere shell of the compact tissue. The periosteum which has been separated from the bone does not perish, but throws out new bone, which forms a sheath or casing around the necrosed portion, in which are left many apertures through which the pus escapes. The new bone is called the *invaginating sheath*, and the apertures in it *cloacæ* (fig. 165). As a consequence of this condition infective phlebitis and thrombosis of the veins of the bone and parts around may take place, and infective emboli are liable to become detached and cause secondary foci of suppuration in other parts of the body.

Etiology.—The disease generally occurs before puberty, and in boys much more commonly than in girls, on account of their being more exposed to trivial injuries. When there is no history of an injury it has often been of a comparatively slight character, and may have been entirely forgotten. The disease appears to occur in those who are feeble, delicate, or ill nourished, especially in tuberculous children. It is sometimes a sequel to exanthematous fevers.

Symptoms.—The attack is generally ushered in very suddenly. The child possibly may have a rigor and become manifestly very ill. There is fever, with a high temperature, 102° to 104° F., and profound constitutional disturbance. Delirium is an early and characteristic symptom. There is intense pain complained of in the part, which is greatly increased on any movement, so that the child shrieks if the limb is moved, or even if the bed is shaken. He cannot bear the weight of the bedclothes. The limb is swollen, tense, with some œdema, and if the affected bone is a superficial one there is redness ; if the bone is deep-seated, as the femur, the skin is white and waxy in appearance. Frequently the constitutional symptoms precede any local manifestation, and the case may be mistaken at its outset for one of the acute specific fevers. The pain and swelling of the limb, which always follow not later than the second or third day, however, negative this. Even after these signs set in the disease may be mistaken for acute rheumatism, but the fact that the swelling involves only one end of the joint, and not the whole articulation, ought to prevent this, and it is rare to have more than one bone involved in acute necrosis, whereas in rheumatism more than one joint is frequently affected. As the disease progresses the child suffers from vomiting and diarrhœa, the high temperature is maintained, and he rapidly emaciates and refuses his food. Symptoms of pyæmia may now appear, and the patient sinks.

Treatment.—The treatment of this condition is to make free incisions down to the bone, so as to relieve tension and let out the effused inflammatory products. The sooner these incisions are made the better; if before suppuration has taken place all the better for the patient, though it is very uncommon for this to occur, as the formation of pus so rapidly follows the effusion. It is only by making incisions freely and early that there is any chance of preventing necrosis taking place. The incisions should be made in the long axis of the limb, and if necessary there must be several, so that the whole of the effused material may escape. When the incision is made through the periosteum it will gape and thus enable the surgeon to thoroughly flush out the cavity between this membrane and the bone. This should be done with some hot antiseptic solution, preferably corrosive sublimate (1 in 2,000). It is desirable in these cases to insert a full-sized drainage tube, so as to prevent the superficial structures filling up the wound and preventing the free exit of the discharge. The wound must be dressed with a thick antiseptic dressing and a splint applied. In many cases this proceeding will be at once followed by a relief of the pain and a subsidence of the temperature. But if this should not be so, and on the following day the patient is found to be still in pain and his temperature high, it will be an indication that the infective inflammation has spread to the medulla and that a condition of osteomyelitis is present. Steps must be at once taken to deal with this. The wound must be exposed and the finger introduced. If the periosteum is found to have been only partially separated from the bone, so that the whole circumference is not involved, a trephine must be applied to the bare bone and the medullary cavity opened. With a sharp spoon as much of the inflamed medulla as can be reached must be scraped away, and the interior of the bone irrigated with an antiseptic solution and a drain inserted. If the whole circumference of the bone has been denuded the bared portion of bone should be removed in its entirety, by sawing through the bone with a chain saw introduced between the bone and the periosteum, or by means of a keyhole saw; or, if the child is sufficiently young to allow of its being done, by cutting the bone through with cutting forceps. In some cases where the denudation of bone has extended from epiphysis to epiphysis the whole of the shaft of the bone may be removed by exposing the bone near its centre, cutting it through in this situation, and drawing the two ends out; having been separated at the epiphysial line there will be no difficulty in doing this. After these operations, where the whole thickness of the bone has been removed, the limb must be carefully adjusted in splints and maintained in a rigidly fixed position. If this is done new bone will be formed from the periosteum, which will fill up the gap, and the patient will have a useful limb without shortening.

In cases where the joint has become implicated and the general condition is grave, amputation may have to be resorted to; as also in cases where prolonged and profuse discharge threatens to exhaust the patient.

The general treatment of these cases must not be neglected. The patient's strength must be supported by a generous and easily digestible diet. Stimulants in small quantities are generally required, and opiates are sometimes called for to diminish irritability and procure sleep. If the patient survive the acute symptoms there will be a long and exhausting illness while the necrosed bone is separating, and an operation for its removal when this has taken place. This will be considered when we come to speak of necrosis.

OSTITIS

In describing ostitis or inflammation of the substance of bone as a distinct disease, and apart from periostitis, it must be understood that this is merely for convenience of description, since the two diseases almost always, except perhaps in their very earliest stages, co-exist, and it is very rare to find the bone substance inflamed without the periosteum and medullary membrane being more or less involved.

Etiology.—Injuries of all kinds are among the most common causes of ostitis; fractures, simple or compound, gunshot wounds and amputations, contusions and burns. Sometimes a very slight injury in certain constitutional states may be the exciting cause of a long abiding inflammation of the bone injured. This is especially so in tuberculosis; the most frequent cause of tuberculous inflammation of a bone is a trivial injury, which is regarded as of little importance at the time. Cold, damp, and malaria are also to be regarded as exciting causes of ostitis, especially in certain specific diatheses, as syphilis, rheumatism, and tuberculosis.

Pathology.—The changes which take place in inflammation of bone are identical with those that occur in inflammation in other parts, except that the same amount of exudation cannot take place, owing to the density of structure of the tissue in which the inflammation is situated. When a bone becomes inflamed there is the same determination of blood and vascular engorgement as is seen in other structures. This is followed by stasis and an emigration of leucocytes through the walls of the vessels in the Haversian canals into the connective tissue which lies in these channels. Very soon the canals become filled with leucocytes. If the process is very acute the canals become so choked that the vessels are pressed upon and occluded, and all circulation in the inflamed portion of the bone is arrested, and necrosis results. What generally happens is that the emigrated leucocytes at once begin to attack, absorb, and replace the walls of the bony canals, so as to form large, somewhat crescentic, erosions, which are known under the name of *Howship's lacunæ*. By this means the size of the vascular channels is increased and they become irregular in outline, and the whole bone becomes more porous and lighter. If a microscopic examination be made of a piece of bone in this condition it will be found that the Haversian canals, instead of presenting a regular outline, are excavated by many hollow spaces, which have been formed at the expense of the osseous tissue around the canal. These spaces are filled with cells, some of which are of considerable size and multi-nucleated. They bear a striking resemblance to the giant cells which are found wherever a bone is undergoing absorption. They are known as *osteo-clasts*, and their exact origin is uncertain. Around these large multi-nucleated cells are a large number of small round cells, which are the emigrated leucocytes.

This process of gradual absorption is known by the name of *rarefying ostitis*, and the inflammatory exudation which takes place into the porous tissue thus formed may undergo various changes, which are identical with those which take place in inflammatory exudation in other parts. In favourable cases where the irritation which produced the inflammation is not long continued, the inflammatory exudation may undergo resolution and the bone return to its original condition. This is only in cases where no absorption of bony tissue has taken place. If, on the other hand, the irritation has been more prolonged and destruction of tissue has taken place, the inflammatory exudation may become organised by small loops of vessels growing into it from neighbouring parts, and converted into a true granulation tissue. This undergoes the same changes as granulation tissue elsewhere. The cells become elongated, spindle-shaped, and converted into fibre cells and then into fibrous tissue. But the process does not stop here; earthy salts are deposited in the fibrous tissue and a true ossification results, and new bone is formed, which, though denser in structure, resembles healthy bone when examined under the microscope. The whole of the inflamed portion of bone is now harder and denser than it was before, and frequently many of the Haversian canals are obliterated, so that the bone acquires more or less the consistency of ivory. This condition is known under the name of *osteo-plastic ostitis* or *sclerosis.* Sometimes, on the other hand, instead of the inflammatory exudation becoming vascularised and converted into a new tissue, its cells perish from malnutrition and degenerate into pus cells, and suppuration is the result. This is what happens when ostitis is set up around a piece of bone which is already dead, and it is by this process that the dead bone is separated from the living. In tuberculous abscess of cancellous tissue the same thing may occur, resulting in the formation of a localised collection of curdy pus, known as *chronic abscess of bone.*

Symptoms.—The symptoms to which ostitis gives rise are pain of a dull, aching, gnawing character, which is liable to exacerbations, being increased by exercise, by pressure, or by a dependent position of the part. Its principal characteristic is that it is worse at night. If the bone is a superficial one, as the tibia, there may be slight dusky redness of the skin. Later on, especially when the periosteum becomes secondarily involved, there is some general enlargement of the bone. The disease is so mixed up with periostitis that it is almost impossible to differentiate between the two conditions, nor is it a matter of any great importance to do so, since the treatment of the two is almost the same. There are, however, one or two points by which a differential diagnosis may be arrived at. In periostitis the enlargement will be on one aspect of the bone alone in the majority of cases, whereas if there is ostitis as well the whole of the bone will be enlarged. It is said that in cases of ostitis, on tapping or percussing the bone, a severe pain is felt to shoot along it, but in periostitis the pain is confined to the part struck.

Treatment.—The treatment of ostitis is the same as periostitis, except that if operative measures are resorted to it will not be sufficient to incise the periosteum, but an opening must be made in the bone. This is done by an operation known as *linear osteotomy.* It consists in making an incision, some three or four inches in length, down to and through the periosteum over the inflamed bone; a Hey's saw is now applied to the bone and a cut made in it down to the medullary canal or deeply into the cancellous tissue. In this way pain may very often be at once relieved. Other surgeons attain the same end by taking out a crown of bone with a trephine. This, though a somewhat more severe proceeding, appears to be attended with more permanent results, since in linear osteotomy the pain is very apt to recur when the cut in the bone closes up.

Results of ostitis.—From the foregoing it will be seen that inflammation of bone may terminate in several different ways and may lead to several different results. These are: (1) a progressive rarefying ostitis, leading to a destructive ulceration, which is known as *caries*; (2) an osteo-plastic ostitis, which is known as *sclerosis*; (3) abscess; and (4) necrosis. These will now have to be considered somewhat more in detail.

1. **Caries** is for the most part a tuberculous disease, but may occur under other conditions. When, for instance, an acute septic inflammation of a joint takes place, with destruction of the cartilages, the progressive ulceration of the articular lamella and underlying cancellous tissue which takes place is spoken of as caries; and again, in syphilitic disease, the superficial ulceration which takes place on the surface of a bone under a subperiosteal gumma is also spoken of as caries. As a rule, however, caries is spoken of as a chronic inflammation of the cancellous tissue of bone, caused by the deposit of tubercle in it, and attended with absorption or rarefaction of the bony tissue and an increase of the cellular elements, which are prone to undergo degeneration and caseation.

Pathology.—Caries may be regarded as a more advanced condition of the rarefactive process which occurs in all inflammations of bone, and where the absorption goes on to such an extent that the whole of the bony structure is destroyed and converted into granulation tissue. The essential features of the disease are the deposit of the tubercle bacillus in or around the blood-vessels in the interior of the bone; this is followed by an absorption of the bony tissue and its replacement by granulation tissue, which shows the characteristic structure of tuberculous disease. We have first hyperæmia and exudation of inflammatory products and formation of granulation tissue, the cells of which crowd the trabecular spaces and the Haversian canals. This gradually destroys and replaces the bony tissue, which disappears in front of it in the form of excavations (Howship's lacunæ). In these may be found large multi-nucleated cells, with processes, surrounded by spheroidal cells and containing rod-shaped bacilli (the tubercle bacillus). Sometimes the granulation tissue, having destroyed the bone, does not undergo caseation, but is in part absorbed and in part undergoes a developmental process and becomes converted into bone. In these cases we have a destruction of the original bony tissue, without the formation of curdy pus. This is called *caries sicca*. Much more frequently the granulation tissue undergoes a degenerative process and caseates: the caseated material then liquefies and forms a curdy pus; with this may be mixed true pus from inflammation of the surrounding tissues. When this occurs, *caries with suppuration* is said to take place, and the chronic abscess slowly finds its way to the surface and bursts, unless subjected to operative interference. In cases where the amount of granulation tissue is excessive and the destruction of the bone rapid, and where it fungates through the skin or into a joint, the term *caries fungosa* is applied. Finally, in some cases, and not infrequently, the granulation tissue itself degenerates before it has absorbed and replaced the bone. This degeneration occurs at the centre of the inflamed area, at the part most remote from the source of nutrition. The bone here dies and becomes separated from the surrounding bone by the living granulation tissue at the periphery, which does not undergo degeneration until it has completed its work of destruction of the original bone tissue in this situation. From this it follows that in these cases we find a mass of necrosed cancellous bone often of considerable size floating in a collection of curdy pus. The necrosed portion is soft and spongy from the rarefying process which has proceeded to a certain extent in it. This condition is spoken of as *necrotic caries.*

Caries is most common in cancellous bone, where red marrow is found, such as the bones of the carpus and tarsus, the bodies of the vertebræ and the ends of the long bones.

The **symptoms** of caries are very insidious, and in the early stages are impossible to distinguish from chronic ostitis. The first symptom is generally pain of a dull aching character in one of the short bones, or extremity of one of the long bones. The pain is increased by pressure or jarring the bone. This is followed by some enlargement of the bone. So far the symptoms resemble those of chronic ostitis, but after a time a dusky redness of the skin, with swelling and infiltration of the soft parts over the bone, and possibly an indistinct sensation of fluctuation, show themselves and indicate the condition as one of caries. After the abscess has been opened or burst, the introduction of a probe will give the sensation of roughened and bare bone, which is soft, and in which the probe can be buried. In many cases symptoms of caries may be altogether absent, or so slight that they do not attract attention, and under these circumstances a fluctuating swelling at some distance from the surface may be the first indication of the disease.

Treatment.—In the early stage, the treatment of caries consists principally in keeping the part at absolute rest. If there are any symptoms of acute inflammatory trouble, means must be taken to subdue them by appropriate local and general remedies; but in the great majority of cases there is nothing of this kind, and the disease is essentially chronic from the first, and under these circumstances means should be taken to maintain the absolute immobility of the part and keep it at perfect rest. Combined with this, change of air, especially to the seaside, and plain nutritious food should be prescribed. Cod-liver oil, the iodides of iron and potassium, should also be given. As soon as definite signs of softening present themselves, operative interference should be undertaken, and this, if possible, should be done before pyogenic infection has taken place. The successful treatment of a case of tuberculous caries will depend in a great measure upon whether the pyogenic organisms have effected an entrance or not. An incision should be made and the bone opened, and all caseous products gouged away. This should be done very thoroughly and the part flushed with some antiseptic solution. The cavity which is left should be stuffed with iodoform gauze and the wound sutured, the end of the gauze being left protruding through a small opening in one angle of the wound, so that it can be withdrawn at the end of forty-eight hours. If there is no pyogenic infection and the whole of the diseased tissue has been removed the wound will probably heal, and if there is no recurrence the case will be at an end; but if any pus is present, the wound will not heal by primary union, and in many cases a recurrence of the disease will take place in the surrounding bone. When this is so and the disease is situated in some accessible bone, such as one of the bones of the carpus or tarsus, excision of the whole bone seems to hold out the best prospect of a cure. Where several bones are implicated amputation may be necessary.

2. **Osteo-plastic ostitis.**—This has already been alluded to in speaking of the pathology of ostitis. It is simply the curative process of a chronic ostitis which has gone on to the destruction of bone tissue. In those cases where the bone tissue has been destroyed by the invading

leucocytes, the excavations formed become filled with vascularised granulation tissue which develops into bone. The bone thus formed is denser and harder than normal bone, and presents the appearance of ivory. The Haversian canals are very small and few in number, but otherwise, on microscopic examination, it is found to possess the structure of true bone. This condition is sometimes known by the name of *sclerosis*.

The **symptoms** are those of chronic ostitis, with evidence of increase in the size of the bone. The pain is not usually severe, and is more a sensation of weight and heaviness in the part than actual pain; though sometimes at night the pain may be of a dull aching character, and may prevent the patient from sleeping. Upon examination of the bone and comparing it with the one of the opposite side, it will be found to be larger and generally somewhat irregular on the surface. A skiagraph will at once demonstrate the increased size of the bone.

Treatment.—No very definite rules can be laid down for the treatment of this condition, nor indeed in the majority of cases is any treatment necessary. As we have said, it is merely the curative process of chronic ostitis, and as such must be looked upon as a permanent condition. When it occurs in a syphilitic subject, as it most frequently does, the administration of mercury and iodide of potassium is indicated, especially if pain is complained of. This will probably prevent any extension of the disease, but will have little or no effect on the enlargement which has already taken place. In some cases the pain is much more severe, and relief may be afforded to it by drilling the sclerosed bone in different situations.

3. **Abscess in bone.**—By the term *abscess in bone* is meant a circumscribed collection of pus, which is sometimes found in the cancellous tissue of the ends of the long bones (fig. 166), more especially of the tibia, though other bones, as the femur, humerus, radius and ulna, are sometimes affected.

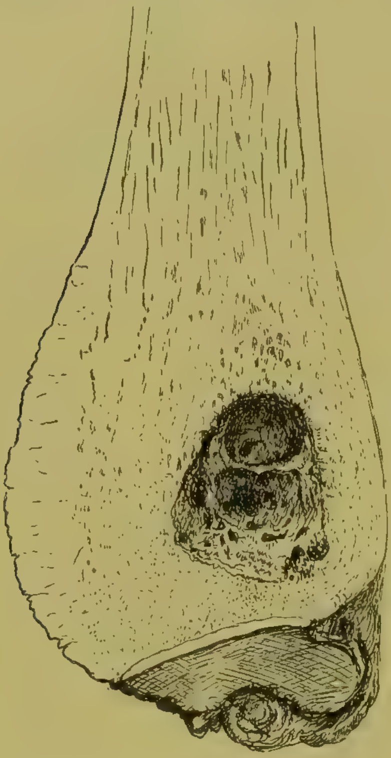

FIG. 166.—Chronic abscess in the lower extremity of the tibia. (From the Museum of St. George's Hospital.)

Pathology.—The condition is probably always tuberculous in its nature. In consequence of some slight injury to the highly vascular growing end of the shaft of a long bone, an inflammation is set up and a suitable nidus is formed for the growth of the tubercle bacillus. It effects a lodgment here, and tuberculous nodules are formed in a mass of granulation tissu which has destroyed and replaced the bone tissue. This caseates an liquefies, and a cavity is formed containing curdy pus and generally line by a distinct pyogenic membrane. The bone around undergoes an osteo plastic ostitis, which limits the extension of the disease. The amount o fluid contained in these abscesses is generally very small, probably no more than a drachm. The disease usually occurs in the young.

Symptoms.—The symptoms at first are those of chronic ostitis. Sever aching, gnawing pain is complained of at one particular spot, in the en of one of the long bones. This is especially severe at night; in fact, during the day the patient may be able to go about his ordinary avocations suffering little or no inconvenience, but as soon as he gets warm in bed the aching, gnawing pain will commence and prevent his sleeping. The pain is also intermittent in character. At times it will disappear altogether for weeks or months, and then reappear without any assignable cause. Upon examining the limb it will generally be found that there is definite tenderness at the spot where the pain is complained of, and firm pressure in this situation may cause an excess of pain, which may last for some hours before it subsides. Sometimes slight enlargement of the bone may be detected, and later on a little dusky red patch may appear at the painful spot.

Treatment.—The treatment in these cases consists in making a crucial or T-shaped incision over the painful spot down to the bone and applying a trephine in this situation. The trephine need not be a large one, and should be made without any overhanging shoulder, so that it can penetrate to any depth. When it is judged that the centre of the bone is reached the trephine must be withdrawn, and a little pus will probably follow. If not, the neighbouring bone should be pierced with a small gouge in every direction, when probably the abscess will be opened. Should, however, no pus be found, the operation will nevertheless probably relieve the patient, as the case will be one of ostitis in which no matter has formed. Some surgeons recommend perforating the bone in the first instance with a drill until the pus is found, and then using the drill as a guide to the abscess. Others recommend opening it with a gouge. After the pus has been evacuated the cavity should be well scraped with a sharp spoon, to get rid of any granulation tissue, flushed and packed with iodoform gauze.

4. **Necrosis.**—Death or necrosis is another result of ostitis, but as it may also result from osteo-myelitis its description will be deferred until that disease has been considered.

OSTEO-MYELITIS

Inflammation of the marrow of bone, *osteo-myelitis* or *endostitis*, resembles in its features inflammation of other soft structures, and may be divided into (1) simple, localised osteo-myelitis, which may be acute or chronic, and (2) diffuse septic or infective osteo-myelitis.

1. **Acute simple osteo-myelitis** is traumatic in its origin. It is generally the result of an injury to the bone, exposing the medulla, as in compound fracture or amputation; but no doubt it occurs in a minor degree in simple fractures, forming the internal callus. In these latter cases, however, it never runs on to suppuration, the inflammatory products being converted into bone. When the medulla is exposed the inflammation may run on to suppuration, and under these circumstances may spread some distance up the bony canal. In amputation it is this form of osteo-myelitis which closes the medullary canal. The treatment consists in keeping the wound, if there is one, aseptic.

Chronic simple osteo-myelitis is of little or no clinical importance, and indeed is nothing more than a part of general ostitis and periostitis. Thus, in chronic osteo-plastic ostitis the medullary canal becomes narrowed by an inflammatory condition of the marrow, leading to the formation of bony tissue, which may eventually close it.

2. **Acute infective** or **septic osteo-myelitis** presents itself under two different forms: (1) as a result of infection from without, e.g. in cases of compound fracture and after amputation: and (2) as a result of infection from within, when it is closely related to and probably identical with acute septic periostitis, which has already been described.

1. In the former class of cases there must be some injury exposing the marrow of bone and permitting the introduction of micro-organisms, probably the staphylo- or strepto-cocci. The medullary membrane becomes injected, studded with ecchymoses, and very soon breaks down into suppuration, which first shows itself as little isolated abscesses, which after a time coalesce, and the whole of the medullary tissue is converted into pus (fig. 167). The circulation in the bone being cut off, it necroses, and, if the patient survive, a varying amount, according to the extent of the inflammation, separates. In cases of amputation this sequestrum is usually annular and conical in shape (fig. 168), a small portion of the whole thickness of the bone perishing below and only the interior of the bone above, and this becomes less and less in amount as the disease extends upwards. In these cases the patient runs considerable risk of septicæmia and pyæmia, from septic thrombi forming in the veins and becoming detached and carried into the circulation.

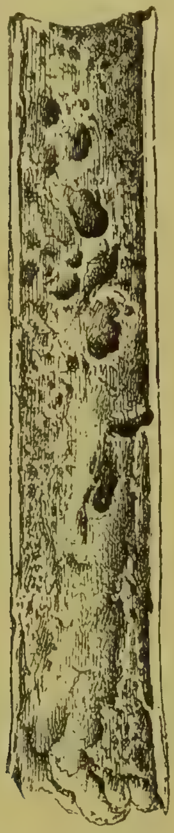

Fig. 167.—Acute septic osteo-myelitis of the femur. (From the Museum of St. George's Hospital.)

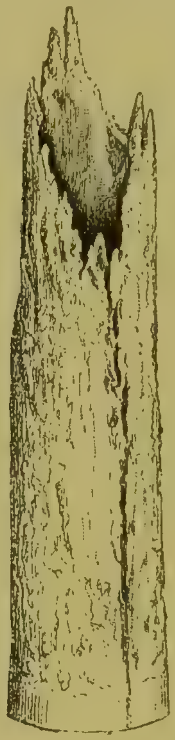

Fig. 168. — Conical sequestrum after amputation of the thigh. (From the Museum of St. George's Hospital.)

Symptoms.—After an injury or operation involving the interior of a bone, in which suppuration has taken place, the patient has a rigor with deep-seated pain in the part, and an unhealthy and infiltrated condition of the soft parts. If the case is one of amputation, the end of the bone will be seen to be denuded of periosteum, and a fungous mass projecting from the cut surface of the bone. Accompanying this will be symptoms of high fever, repeated rigors, profound constitutional disturbance, and delirium. Unless active measures are at once undertaken, the patient will rapidly succumb to pyæmia.

Treatment.—The treatment of this condition must be energetic and undertaken at once. It consists in laying the wound freely open, and exposing the medullary canal. All the inflamed marrow must be scraped away with a sharp spoon as high as can be reached. The cavity is then to be flushed out with a strong solution of corrosive sublimate (1 in 1,000), and a drainage tube inserted for a few days. If there is any doubt about the whole of the medullary tissue not having been removed, it is a wise precaution to swab out the cavity with pure carbolic acid or solution of chloride of zinc (gr. xl to ℥i). All the soft parts around must be carefully disinfected. If this plan of treatment succeeds, it will be followed by a subsidence of the general symptoms; should this not occur, amputation through the joint above the bone implicated must be undertaken as a last resource.

2. In cases where acute septic osteo-myelitis occurs from infection from within, the virus is believed to be carried to the affected bone by the blood. It runs the same course as diffuse septic periostitis, and speedily results in a panostitis or septic inflammation of the whole of the structures of the bone, and terminates in complete necrosis, should the patient survive. The disease is characterised by great constitutional disturbance, a high temperature, rigors, and early delirium, and combined with this acute deep-seated pain in the bone.

In these cases the only **treatment** is to remove the infecting focus, and this can scarcely be done except by amputation. The whole of the bone implicated must, in most cases, be removed; but inasmuch as in cases of infective osteo-myelitis of the femur amputation at the hip joint would probably prove fatal, amputation should be performed high up in the thigh, and the medullary tissue scraped away from the stump of the bone, and the cavity disinfected.

EPIPHYSITIS

Epiphysitis is the name given to an infective disease of the ends of the long bones, in the neighbourhood of the epiphysial cartilage, which more often affects the growing end of the shaft than the epiphysis itself. It may occur as an acute, subacute, and chronic condition.

Acute epiphysitis is a disease almost entirely confined to infants under twelve months of age, and is an infective condition, similar in nature and origin to the diffuse septic periostitis and osteo-myelitis which have already been described, and is due to the invasion of the part with pyogenic cocci. The mode of origin of the infection is not always clear. In quite young infants it may be due to changes during the separation of the cord, but in a large number of the cases there is the history of some slight injury or strain. It affects most frequently the upper end of the humerus or one or other extremity of the femur. The inflammation rapidly runs on to suppuration, and the epiphysis becomes separated from the shaft of the bone. In some cases the whole of the epiphysis may be involved in the inflammatory infiltration, and may die. In others it may be perforated, and pus may find its way into the joint, and acute arthritis, the 'acute arthritis of infants' (Sir T. Smith), be set up. Again, in other cases the pus may burrow laterally, and open into the joint. This is especially the case in the upper end of the femur, where the epiphysial line lies within the capsule.

Symptoms.—In many of these cases a history may be obtained of some sudden jerk or strain. The first noticeable signs are that the child becomes fretful and listless, and cries out when one particular limb is moved. On examination a swelling, painful on pressure, will be found in the neighbourhood of one of the joints of this limb. The swelling will be found at this early period of the case to be in the neighbourhood of the epiphysial cartilage, and perhaps to be greater on one side of the bone than the other. Later on the swelling will be much increased and involve the articulation, indicating that the joint has become implicated. In some cases, on moving the limb a grating will be detected, denoting that the epiphysis has become separated. Conjoined with these local signs there is a febrile condition. The temperature rises, and very soon the child becomes manifestly very ill. The face is pale and contorted, sleep is disturbed, and the secretions disordered. It is frequently sick, and often refuses food, and unless prompt measures are taken, rapidly dies from exhaustion or pyæmia.

Treatment.—The treatment consists in free incision, with evacuation of the matter, and removal of all the diseased tissue. If the joint is implicated it must be freely opened, washed out with antiseptic solution, and a drainage tube inserted. This will in most cases suffice, if the focus of disease is removed from the end of the shaft of the bone. But in those cases where the epiphysis is more or less completely disorganised, it will have to be removed, though this should always be avoided if possible, as the epiphysial cartilage will be removed with it, and the future growth of the bone interfered with. After all diseased tissues have been removed, the parts should be thoroughly flushed, a drainage tube inserted, and the parts dressed with antiseptic gauze.

Subacute epiphysitis.—A form of the same infective disease, which does not run quite such an acute course, is occasionally met with in older children. The main difference in these cases is, that the epiphysis being more or less bony, the matter rarely burrows through it, and perforating the articular cartilage, invades the joint. It usually spreads along the under surface of the epiphysial cartilage to the circumference of the bone. In those cases where the epiphysial cartilage is within the capsule, as in the upper end of the femur, it now invades the joint; while in those where the epiphysial cartilage is outside the capsule, an abscess forms external to the articulation.

Symptoms.—In these cases the symptoms are not nearly so acute, and there is not the same profound constitutional disturbance. There is almost always the history of some injury, followed, after a time, by pain on moving the injured limb, which the child keeps absolutely at rest. In the neighbourhood of the epiphysial cartilage will be noticed a circumscribed swelling, which fluctuates, and the skin over it will probably be reddened. On manipulating the parts in most cases crepitus will be detected, and lateral mobility discovered. There is not usually any great amount of fever. These cases, if properly treated, usually progress to a satisfactory termination.

The **treatment** consists in making a free incision and in clearing out the abscess cavity and scraping the exposed bony surfaces. The parts are then thoroughly irrigated and a drainage tube inserted. In these cases the subsequent growth of the bone may be impaired or arrested.

Chronic epiphysitis is probably always a tuberculous or syphilitic affection, and will be considered with the other forms of specific diseases of bone.

NECROSIS

The death of the whole or part of a bone, *en masse*, without any marked alteration in its structure, is termed *necrosis*. It corresponds to mortification of the soft parts.

Etiology.—Necrosis is for the most part caused by an arrest in the circulation through the bone. This may be due to injury, from tearing off of the periosteum in a case of compound fracture, or it may be due to the vessels becoming blocked or destroyed, as the result of the inflammatory process; thus, in chronic ostitis the vessels may be blocked by the exudation taking place into the Haversian canals; or in acute periostitis and endostitis the nutritive supply may be entirely cut off and extensive necrosis result. Inflammation of the soft parts around, as in whitlow, may give rise to necrosis, by spreading to the periosteum and bone. Syphilis and tubercle may also give rise to death of a portion of bone. Necrosis of the jaw may occur from exposure to the fumes of phosphorus, and was formerly a common disease among lucifer match makers, the acrid fumes gaining access to the bone through carious teeth. Mercury, if given in excess, may also cause necrosis of the jaw.

Pathological anatomy.—Necrosis varies in extent and in the part of the bone affected according to the cause which gave rise to it. In those cases where the necrosis arises from an injury, stripping off the periosteum and denuding the bone, the outer laminæ only perish, and to this condition is given the name of *peripheral necrosis*; where there is a limited inflammation of the cancellous tissue, generally tuberculous, which leads to the death of a portion of bone, as in chronic abscess, the term *central necrosis* is used; and where, as in cases of panostitis, the whole thickness of the bone is destroyed, the term *total necrosis* is applied. The portion of bone which dies is called a *sequestrum* (fig. 169).

A portion of bone having died, it has to be got rid of, and in order to effect this it has to become separated from the living bone with which it is in connection. This is brought about by an analogous process to that by which sloughs in soft parts are got rid of. An inflammation, attended by exudation, takes place in the living parts in contact with the dead, and the migrated leucocytes which infiltrate this inflamed tissue gradually destroy and replace the bone, so that after a time the living bone in contact with the dead is transformed into a layer of granulation tissue. Part of this tissue then degenerates and becomes converted into pus, and the dead bone lies loose in an abscess cavity, the walls of which are formed by the rest of the granulation tissue. If the periosteum over the necrosed portion has not been destroyed, but merely separated, new bone is formed on its under surface, and thus the abscess cavity containing the sequestrum becomes inclosed in a bony case formed partly by the remains of the original bone which has not died, and partly by the new bone formed from the periosteum (fig. 170). In this ensheathing bone are a number of openings, termed *cloacæ*, which allow of the escape of pus. Where the periosteum has been torn off or destroyed, in cases of peripheral necrosis, there is usually no ensheathing bone, and the sequestrum when it separates is said to exfoliate.

Symptoms.—The symptoms at first vary according to the cause of the necrosis, and are those of the disease which produced the condition, whether periostitis, ostitis or osteo-myelitis, but in all there is suppuration, and one or more sinuses are present. These sinuses are often funnel-shaped and usually present at their orifice florid granulations. They discharge thick pus, which is often foul-smelling and frequently of a brownish red colour. The bone beneath will be felt to be enlarged and thickened. On passing a probe, it will strike with a hard ringing sound on the smooth surface of the sequestrum. If the sequestrum is small the discharge will be slight, little or no thickening of the bone will be felt, and there will be only one sinus, or if more than one they will be close together; whereas if the sequestrum is large there will be copious discharge, considerable enlargement of the bone, and several sinuses, often at a considerable distance from each other, through all of which exposed bone can be felt with a probe.

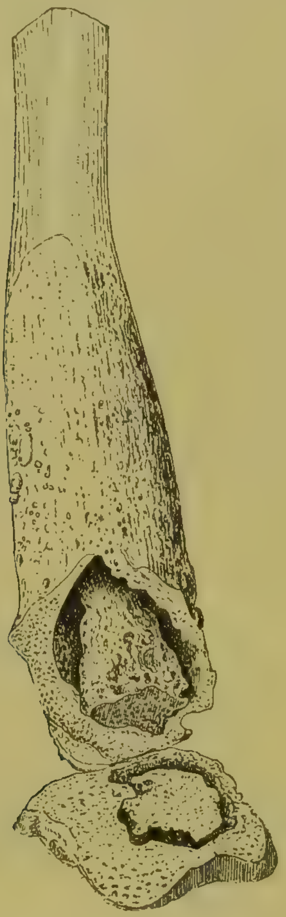

FIG. 169.—Necrosis of the lower extremity of the tibia, involving part of the articular surface of the ankle joint. (From a drawing in the Museum of St. George's Hospital.)

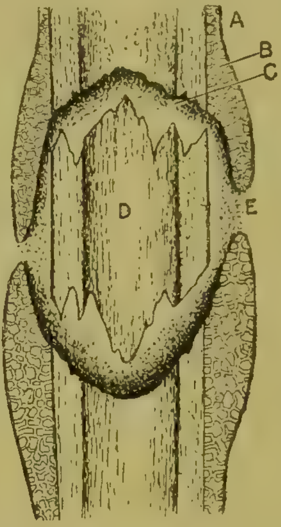

FIG. 170.—Diagram representing the process of separation of necrosed bone. A, periosteum; B, new bone; C, granulation tissue; D, necrosed portion; E, cloaca.

As bearing on the treatment, it is necessary if possible to ascertain if the bone is loose; that is to say, that it has become separated from surrounding living bone. In arriving at a conclusion on this point the surgeon will be guided to a certain extent by the duration of the disease, though this is subject to considerable variation. Necrosed bone separates much more quickly in the young than in the middle-aged or old, and it separates more quickly in the upper extremity than the lower. The extent of the necrosis will also influence the period at which separation will have taken place, and it will generally be found that in superficial or peripheral necrosis exfoliation will take place more rapidly than separation of a central or total necrosis. Other indications of the complete separation of the fragments will be afforded by probing. The sequestrum may be felt to move its position when the probe is introduced; or if there are two sinuses and a probe is passed down each and alternate pressure made, a sort of see-saw movement will be communicated to the necrosed bone if it is loose.

Treatment.—As soon as the surgeon is satisfied that separation of the sequestrum has taken place, it should be removed. In many instances this is a comparatively simple proceeding. In cases of peripheral necrosis, for instance, it may be merely necessary to enlarge the sinus in the soft parts, and with a pair of sequestrum forceps withdraw the piece of dead bone; or in cases of a tubular sequestrum, the result of osteo-myelitis after amputation, the dead bone can readily be extracted. But where the necrosed portion of bone is invaginated in a cavity surrounded by new bone (fig. 165), this will have to be cut away before the sequestrum can be removed. This is to be done by making an incision and freely exposing the invaginating bone with its cloacæ, and enlarging these by cutting away the new bone between them. Generally it is advisable to select two sinuses near the middle of the necrosed portion, if this is of considerable extent, and by joining these, by cutting away the invaginating bone between them, to expose the sequestrum near its centre. This can now be cut in half, and the two pieces removed through the same opening. The surgeon must be careful to leave no dead bone behind in the cavity. The wound, having been carefully flushed to remove blood clot and débris, is to be packed with antiseptic gauze and dressed. The cavity will take some time to fill up, during which time the patient's strength must be supported. Care must be taken to prevent the accumulation of discharge in this cavity, otherwise it will decompose and become foul and produce serious constitutional disturbance.

Quiet necrosis (necrosis without suppuration).—In some cases of necrosis no suppuration occurs. This form of necrosis would appear to be due to arrest of the circulation from choking of the Haversian canals in osteo-plastic ostitis, in cases where no pyogenic organisms are present. The symptoms are those of chronic enlargement of the bone, accompanied by pain, and there is great resemblance to malignant tumour of bone, from which it cannot frequently be distinguished without an exploratory incision. The possible occurrence of this disease should be present in the mind of the surgeon in dealing with supposed malignant tumours of bone; and if there is the slightest doubt, an exploratory incision should be made before resorting to amputation.

TUBERCULOUS DISEASE OF BONE

Tuberculous disease may affect either the periosteum, the bone, or the medullary tissue.

Tuberculous periostitis consists in a deposit of tubercle in the deeper layers of the periosteum. It here sets up inflammation, and the inflammatory products caseate and form a chronic abscess. The subjacent bone is generally involved, and becomes softened and worm-eaten. In these cases there is a localised swelling of an indolent nature, tender on pressure, but causing little pain. It slowly softens and can eventually be felt to fluctuate. If an incision is made curdy pus is evacuated and the surface of the bone will be felt, on probing, to be roughened and easily broken down.

Tuberculous ostitis.—Tuberculous disease of bone affects the cancellous tissue, and has already been described under the head of caries. It begins as a small hard nodule of tubercle in the red marrow of cancellous tissue. This sets up inflammatory changes, and the part becomes infiltrated with round cells, which replace the bony tissue and then undergo fatty degeneration and caseation, and caries is set up. The symptoms are those of caries as detailed above (page 469). The disease may attack the growing tissue of bone in the neighbourhood of the epiphysial cartilage, and is then known under the name of *tuberculous epiphysitis*. When this cartilage is situated within the capsule, as in the upper end of the femur, the joint becomes involved secondarily and may undergo complete destruction. This is probably the most frequent way in which tuberculous disease of the hip joint is set up. It will be referred to more in detail in connection with diseases of joints.

Tuberculous osteo-myelitis.—Tubercle may be deposited in the marrow of the shafts of the long bones, and set up a condition of tuberculous osteo-myelitis. It is most frequently met with in the metacarpal bones and the phalanges of the fingers, when it is known as *tuberculous dactylitis*. The bone becomes expanded and forms a casing to a mass of cheesy material in its centre. The expansion takes place by a deposit of new bone under the periosteum, while a process of rarefactive ostitis goes on in the interior. Eventually, however, the shell of bone becomes perforated, and the superficial soft structures become involved in the disease. Frequently the whole or a portion of the shaft of the bone necroses.

Symptoms.—The affected bone slowly enlarges, with a varying amount of pain and disability. This continues for some time, and then the skin becomes of a dusky red hue, the swelling increases more rapidly, and finally softens at one spot and gives way, discharging curdy pus. On probing, exposed and softened bone will be felt. The neighbouring joints are frequently involved in the disease.

Treatment.—In the early stage the part should be kept strictly at rest and constitutional treatment adopted; change to the seaside; careful attention to diet and hygiene; and cod liver oil administered internally. As soon as the surgeon is satisfied that caseation has taken place, an incision should be made down to the bone, which should be laid open with a small gouge and the cavity in its interior freely exposed. This must be thoroughly scraped out with a sharp spoon, irrigated to wash away all débris, and, having been sprinkled with crystals of iodoform, packed with antiseptic gauze and dressed. If this is done thoroughly and early, the cavity may fill up from the bottom and the case be brought to an end; but if the disease is allowed to go on until the soft parts over the bone become implicated, or if the whole of the caseated material is not removed, sinuses will form, the greater part or the whole of the bone will be destroyed, and the patient recover with great deformity of the finger. In some cases amputation will have to be resorted to.

SYPHILITIC DISEASE OF BONE

Syphilis may affect bone both in the secondary and tertiary stages.

Secondary syphilitic disease of bone.—This always occurs as a periostitis. In quite the early stages of secondary syphilis patients will sometimes complain of aching pains in their superficial bones, such as their tibiæ, the bones of the skull, the sternum, ribs and clavicles, and upon examining these bones slight irregularities or swellings may be discovered which are very tender to the touch. These, however, are not of much importance, and speedily disappear as the treatment of the general condition by mercury is persevered with. It is well, however, to combine with this some iodide of potassium, which generally relieves the pain at once. In the later stages of secondary syphilis a more pronounced condition may appear. This consists in the formation of a single periosteal node on one of the subcutaneous bones and more particularly the tibia. It consists in a thickening and infiltration of the periosteum, which generally goes on to the formation of bone, and is accompanied by a chronic ostitis of the bone in the neighbourhood. The condition is at once recognised by the presence of a hard firm swelling connected with a bone in a syphilitic subject. It is accompanied by aching pain, which is always worse when the patient is warm in bed. The **treatment** consists in the administration of iodide of potassium, which if given in the early stage may cause the entire removal of the swelling, but later on only gives temporary relief to the pain, and a permanent swelling remains, which, whenever the patient gets run down or out of health, becomes the seat of renewed pain.

Tertiary syphilitic disease of bone may show itself (1) as a gumma either in the deeper layers of the periosteum or in the medullary canal; or (2) as an overgrowth and infiltration of the connective tissue of bone, going on to sclerosis.

1. **Gummata of bone.**—When this occurs in the periosteum it consists in the formation of a gummatous deposit in the deeper layers of this membrane and between it and the bone. The disease especially affects the calvarium, and may lead to extensive destruction. The gummatous deposit very commonly undergoes degenerative changes and breaks down, destroying the superficial structures over it and forming extensive ulcers, at the bottom of which bare bone may be felt. An extension of the ulcerative action to the bones accompanies this condition and disintegrates the bone beneath, constituting *caries*. This is often accompanied by *necrosis*, when portions of the implicated bone die *en masse*, because its vitality has been so much interfered with, partly by the blood supply from the periosteum being cut off, and partly because a more or less diffused osteosclerosis takes place in the bone around, and thus materially interferes with the circulation in the affected area. Thus the two processes of caries and necrosis are going on at the same time, and we often get a plate of dead bone, surrounded by an extensive worm-eaten area where the process of caries is going on.

When the gummatous deposit takes place in the medullary structure of bone or in the diploë of the bones of the skull, expansion of the compact tissue first takes place; then the gumma breaks down, the bone becomes necrosed and separates, and the broken-down products are set free.

Symptoms.—A gummatous tumour on the surface of a subcutaneous bone first shows itself as a more or less circumscribed swelling, which is very painful at night and is tender on handling. In this it resembles the periosteal node of secondary syphilis, but after a time it will be found on examination that there is an area of softening in some part of the swelling which does not exist in the other affection. If the case is left to itself this area of softening will increase, the skin will become undermined and eventually give way, and a wash-leather slough will be discharged, leaving exposed and diseased bone.

Treatment.—The treatment of this tertiary affection of bone is by iodide of potassium, and under its use the nodes will often entirely disappear. Even after softening has taken place and the skin has become thin and undermined, the administration of iodide of potassium in full doses will cause complete absorption, so that it is never right to incise these swellings, but to allow them to open of themselves. In those cases where iodide of potassium does not exert its wonted influence, it will be found that the gummatous swelling will often disappear under a course of mercury. When the gumma has given way and there is an open wound, rigid cleanliness must be enforced, frequent cleansing with antiseptic solutions, the local application of iodoform, and an antiseptic dressing is necessary. Any necrosed pieces of bone must be removed as soon as they are loose, and the carious surface scraped with a sharp spoon. The constitutional treatment by iodide of potassium must be continued, but it does not seem to have the same potent effect in those cases where there is an open wound.

2. A **diffused ostitis** is another way in which tertiary syphilis asserts itself in bone, without the presence of any definite node. This consists in an infiltration of the osseous tissue going on to sclerosis. It usually attacks the bones of the skull and the long bones, especially the tibia. The bones become enlarged, elongated and expanded, dense and heavy. The surface of the bone becomes nodulated and irregular, from the formation of new bony material from the periosteum, but does not present limited nodes as in the secondary form of syphilitic disease. The interior of the bone becomes filled up by the formation of new hard bone, so that the medullary canal becomes entirely obliterated.

The **symptoms** of this condition are steady and progressive increase in the size of the bone, accompanied by deep-seated aching pain, which is increased by exercise and is worse at night. This, with the history of a previous attack of syphilis, is characteristic of the disease. The only complaint with which it is liable to be mistaken is ostitis deformans, where one bone only is involved, but the bone in this affection is not so heavy as in syphilitic sclerosis; it is usually curved and distorted, and after a time other bones become similarly affected.

Treatment.—No treatment seems to be of any avail in diminishing the enlargement, but relief to the aching pain may be given by the free administration of iodide of potassium.

Bony lesions in congenital syphilis.—In addition to the conditions of atrophy and hypertrophy alluded to in the chapter on Syphilis (page 197) as occurring in inherited or congenital syphilis, periosteal nodes are occasionally met with on the tibia and other long bones, but do not differ much from those of the acquired form of the disease. More commonly there is set up in these cases a diffused ostitis, which almost always affects the tibia and is very often symmetrical. The bone becomes enlarged and elongated with an anterior curvature, and the result is a permanent elongation of the leg. The diagnosis is to be made by the presence of other evidences of inherited syphilis. The treatment must consist in the administration of the ordinary remedies for inherited syphilis, but nothing seems to be of much service in remedying this condition.

Syphilitic dactylitis occasionally occurs in children the victims of inherited syphilis. It consists in a gummatous deposit in the medullary tissue of the metacarpal bones and phalanges of the fingers. It leads to expansion of the bone, and may be mistaken for tuberculous dactylitis, but it usually yields readily to iodide of potassium, and the diagnosis is to be made by the history of the case and the effects of treatment.

HYPERTROPHY AND ATROPHY OF BONE

Hypertrophy of bone is a term which has been very loosely applied, and is often made to include those instances where an enlargement of bone has taken place as the result of inflammation or structural changes; but clearly the term *hypertrophy of bone* should be confined to those cases where the increase in size has been without any alteration in form and structure, and these are very rare. The best and truest illustration of true hypertrophy of bone are those cases where the bone becomes enlarged and stronger, with greater development of its ridges and processes, from excessive muscular action, as in the arm of a blacksmith. But other examples of hypertrophy are met with. Thus we may have hypertrophy of one of two parallel bones when the other is partially destroyed by disease, or we may have a congenital hypertrophy of the bones of one limb which from birth is longer than the other.

Atrophy of bone is very common, in fact it is the usual accompaniment of old age; it also occurs from disuse; from any diminution of nutritive supply, as where the nutrient artery of a bone has been torn across; it is also common in the general paralysis of the insane. The bone becomes light and porous, the cancellous tissue becomes expanded, its meshes disappear, and its red marrow converted into fat; the compact tissue becomes thinned and reduced to a mere shell, so that the whole bone becomes thinner and lighter than natural. This rarefaction of the cancellous tissue and thinning of the compact tissue render the bones very fragile, so that they easily give way and fracture from slight causes.

STRUCTURAL DISEASES OF BONE

Mollities ossium (*osteo-malacia*) is a singular and rare affection of bones, characterised by the absorption of the mineral portion, as a result of which softening takes place, and bending or fracture is liable to occur.

Etiology.—The causes of the disease are obscure. It is much more common in the female than the male, in the proportion of about 10 to 1, and in the majority of cases occurs in connection with pregnancy, the disease showing itself during this condition. Rheumatism, syphilis, prolonged lactation, and insufficient animal food have all been regarded as causes of this disease. It may occur at any age from 20 or under to advanced life, but it most commonly shows itself first between the ages of 25 and 35.

The bones most frequently and first affected are those of the pelvis, then those of the spine, the chest, the lower and upper limbs, and finally, very rarely, the head. During the child-bearing period the disease appears to have a special predilection for the bones of the pelvis.

Pathological anatomy.—The disease consists first of all in an absorption of the earthy matter, and the bone becomes soft, and resembles one that has been soaked in mineral acids, but at this stage microscopic examination shows traces of true bone structure. Subsequently this softened material undergoes a gelatinous transformation, and, being mixed with blood which has been poured out from vessels which have given way in the softened tissue, becomes altered, so that the whole bone is converted into a thin shell of compact tissue immediately beneath a thickened and vascular periosteum, filled with a brownish red, grumous, semi-fluid material which is not unlike splenic pulp. The bones during this process may become bent and altered in shape, or may break under the slightest violence, and in consequence of this the whole trunk may become greatly misshapen and distorted. The deformity which takes place in the pelvis is of the utmost importance in connection with child-bearing, and this part and the lower portions of the spine may be the only parts which are affected with this disease. The weight of the trunk causes an increase in the sacro-vertebral angle, and a lessening of the antero-posterior diameter of the inlet, and from the same cause the pressure of the acetabula on the heads of the femora causes these cavities with the adjacent bone to be pushed upwards and backwards, so that the oblique diameters are also diminished, and the cavity of the pelvis assumes a triradiate shape, with the symphysis pubis carried forwards (fig. 171).

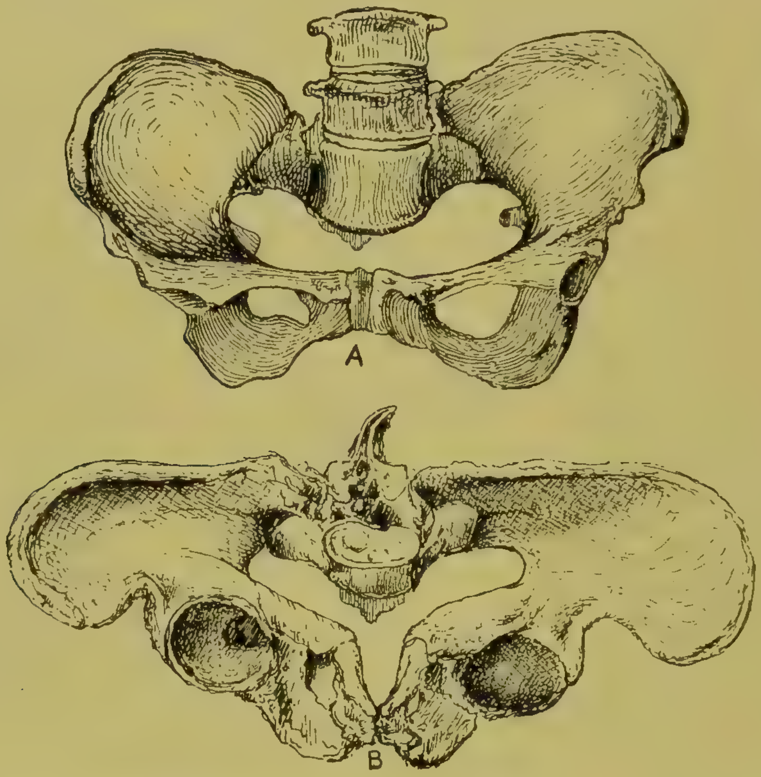

FIG. 171.—Deformity of the pelvis—in A, rickets, and in B, osteo-malacia.

Symptoms.—The symptoms in the early stage are very obscure, and consist of deep-seated pain of an exceedingly persistent character, which is usually ascribed to rheumatism. Conjoined with this the patient loses strength, and becomes emaciated. It is not till some deformity of the bones from bending, or some fracture from a trivial cause takes place, that the true nature of the disease reveals itself. The urine is usually abundant and pale in colour, and contains a great excess of lime salts, probably derived from the softened bones.

Patients suffering from this disease may live for years, crippled and bedridden; but a large number of the cases, occurring as they do during pregnancy, may die from difficulties in parturition, or may require the performance of Cæsarian section.

Treatment.—No remedy is known for this disease, and the only suggestion of any value which has been made is that in these cases the ovaries should be removed. This has been done in some recent cases with benefit, for not only has it seemed to have some effect in arresting the disease, but also it has this advantage that it prevents the possibility of pregnancy.

Ostitis deformans is an inflammatory enlargement of bones, which was first described by Sir James Paget.

Etiology.—The cause of the disease is entirely unknown; it does not appear to have any connection with any of those constitutional conditions in which bone disease is liable to occur, such as syphilis, tuberculosis, or rheumatism. It occurs equally in the male and female, and usually commences after middle life.

Pathology.—The disease attacks principally the bones of the skull, not including those of the face, and the long bones of the extremities. They show changes of an inflammatory character. The bones affected become enlarged, soft, and spongy, and their substance very vascular. The bones which have to bear weight become bent and misshapen. Their surface is roughened. On microscopic examination they are found closely to resemble the conditions of rarefying ostitis; the Haversian canals are found to be eaten out into a series of excavations, which resemble Howship's lacunæ, and which are filled with an exudation material similar to that found in rarefying ostitis, and containing osteo-clasts.

Symptoms.—The symptoms are very insidious. The patient may be noticed to assume a stooping posture, but as the disease does not appear till after middle age this is perhaps attributed to advancing years; the stooping is, however, attended by loss of height and elongation of the upper extremities, so that when the patient is in as erect a position as he can assume the hands reach almost to the knees. In some cases attention has been drawn to the disease by the patient noticing that his hat is always too tight for him, and that he has occasionally to get one of larger size. Upon examination it will be found that the bowed spine is fixed and cannot be straightened, that the ribs are also fixed, and the respiration is mainly diaphragmatic. The girth of the bones of the extremities will be found to be increased, and those of the lower extremities variously bent and distorted. There is usually pain complained of, especially during the earlier stages of the disease, but, unlike other inflammatory affections of bone, this is not increased at night. The disease runs a very slow course, and does not appear to affect the general health of the patient, or to shorten his life, unless some bronchial trouble is set up owing to the embarrassment of the respiratory movements.

Treatment.—No treatment which has been adopted has appeared to have any influence on the progress of the disease.

Acromegaly is a rare affection, which was first described by Pierre Marie in 1885. It is mainly characterised by an enlargement of the hands, feet, and face, but is a general affection involving also other parts of the osseous system.

The enlargement is usually confined to the bones of the face, the bones of the cranium being rarely affected, with the exception of the lower part of the frontal bone and the margins of the orbit. The bones of the face which show the most marked enlargement are the lower jaw and the nasal bones. The enlargement is apparently a mere overgrowth or hypertrophy of the bones, for on microscopic examination they present the structure of normal bone.

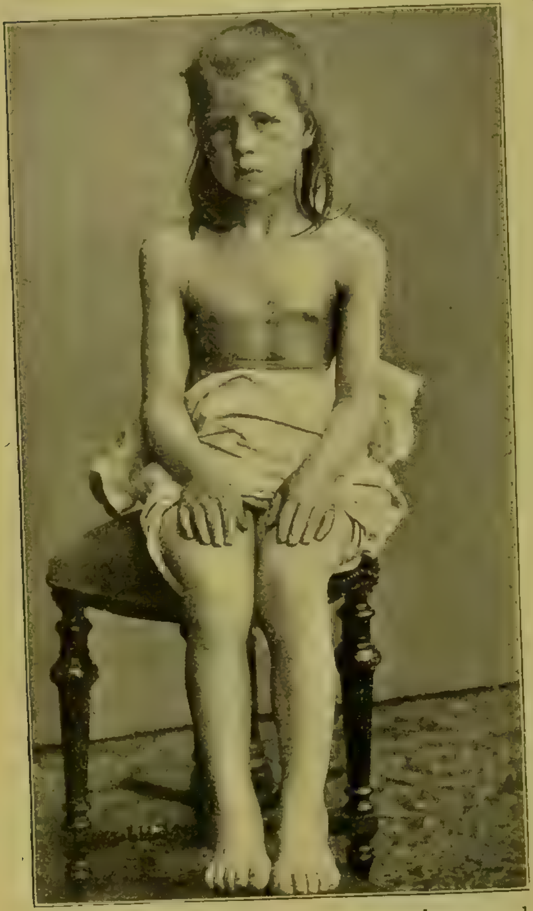

FIG. 172.—Acromegaly. (From a photograph in the Museum of St. George's Hospital.)

Etiology.—Nothing is known as to the causation of this disease. It occurs in both sexes, and generally appears between the ages of 20 and 30, but its advent is so insidious that no definite history can usually be obtained as to the exact time at which the disease made its appearance, the first thing noticed being the alteration in the appearance of the patient.

Symptoms.—The change in the face is the most striking feature. The appearance is dull, heavy, and coarse, and the face assumes the shape of an elongated oval, the eyebrows are prominent and overhanging, the nose enlarged and the chin elongated. The soft parts of the face, and especially the lower lip, are thickened, heavy and bulky. The hands are clumsy-looking, the fingers like 'sausages,' not elongated but increased in girth; the palm increased in width and breadth, but not in length (fig. 172). This is due not only to the very definite enlargement of the bones, but of the soft parts also. In the early stages the rest of the bones of the extremity, i.e. those of the forearm and arm, are not affected; later on these bones may become enlarged, those of the forearm before the humerus. The foot presents a similar condition—increase in breadth and thickness without elongation. There is a marked kyphotic curve in the cervico-dorsal region, and the sternum is prominent, the ribs and clavicles enlarged.

The patient suffers from persistent headache and severe aching pains in the limbs. Severe thirst is often complained of, and in some cases there is constant craving for food. The mental condition is as a rule unimpaired, but there is gradually increasing muscular weakness. Vision is usually diminished and sometimes entirely lost from optic neuritis going on to atrophy of the optic disc. Amenorrhœa is a frequent accompaniment of this disease in the female, and it is said that sometimes in the male it is attended by loss of virile power.

Diagnosis.—There are several diseases for which this condition may be mistaken. (1) Myxœdema, which it somewhat resembles as regards the face, but the swelling is confined to the soft parts. (2) Ostitis deformans, but here there is deformity of the bones as well as enlargement, and the face is not as a rule affected. (3) Leontiasis ossea, a rare disease, presently to be described, affects only the facial bones and the skull, which become irregularly enlarged, but the soft parts are normal. (4) Osteo-arthritis, when it affects the hands, may be mistaken for acromegaly, but in this latter affection there is much less pain and no evidence of joint disease.

Pathology.—The pathology of this disease is unknown. The most remarkable condition which has been found on post-mortem examination is enlargement of the anterior lobe of the pituitary body, but this has not been found in every case. The enlargement is apparently merely an hypertrophy of the gland tissue, and is no doubt the cause of the optic neuritis and atrophy of the disc and consequent blindness. In other cases of acromegaly enlargement of the thyroid body has been noticed, and, again in others, persistence of the thymus gland has been credited with being the cause of the disease.

The patient generally dies from exhaustion, or from some intercurrent malady.

Treatment.—There is no known treatment for this condition ; the case must simply be treated on general principles, with a view to supporting the patient's strength and relieving his most urgent symptoms, especially the headache. Phenacetin or antipyrine may be administered for this.

Hypertrophic pulmonary osteo-arthropathy is another condition of the bones which was first described by Marie, and to some extent resembles acromegaly, but is distinguished from it by the fact that the changes are confined to the extremities, and that there is none of the characteristic deformity of the face which is found in this latter condition. The disease consists in a chronic ostitis and enlargement of the terminal phalanges of the fingers and toes, due, it is supposed, to toxic absorption in chronic pulmonary disease. In some cases the bones just above the wrist and ankle joints are similarly enlarged. The ends of the fingers and toes in these cases are seen to be enlarged, clubbed, and bulbous, and the nails encurved over them. The treatment must be directed towards the pulmonary condition which gives rise to the affection.

Leontiasis ossea is another form of ostitis attended by structural changes in the bones. It affects the facial and cranial bones ; the bones of the jaws being usually first affected. The disease begins in early life, and consists in the slow and gradual development of irregular bosses of bony material, which first block the antra of the upper jaw and the nose and then project externally. The affection spreads to the other bones of the skull and face, encroaches upon their cavities, and produces the most hideous deformity. The masses of new bone, which partake somewhat of the nature of exostoses, are spongy and porous in character, very irregular and nodular on their surface, and often symmetrical. Nothing is known of the cause of this affection, and no treatment seems to be of any use.

TUMOURS OF BONE

The principal tumours of bone are: (1) exostoses, (2) chondromata, (3) fibromata, (4) sarcomata, (5) carcinomata, (6) cystic tumours. Of these the exostoses, the chondromata, and the fibromata have been dealt with elsewhere, and it remains therefore only to discuss the last three.

Sarcoma is a malignant tumour, and is the most important primary tumour of bone, for all *primary* malignant tumours of bone belong to one of the varieties of sarcoma. The structure of these tumours has already been described (page 243), and it is therefore only requisite in this place to allude to their clinical characters. In doing this it is necessary to divide them into two groups, the *peripheral* and *central*, for it will be found that there are the most important clinical distinctions between these two classes of tumours.

Central or endosteal sarcoma (fig. 173).—The central sarcomata, as their name implies, start in the medullary tissue and gradually expand the bone within which they grow. This expansion is brought about by new bone being formed on the surface by the irritated periosteum, while the old bone is gradually destroyed and replaced by the tumour as it grows, so that it cannot be said that the bone really expands in the sense of the true meaning of the word. These central sarcomata belong for the most part to the myeloid group, but round- and spindle-celled sarcomata are also sometimes found growing from the interior of bones. These latter

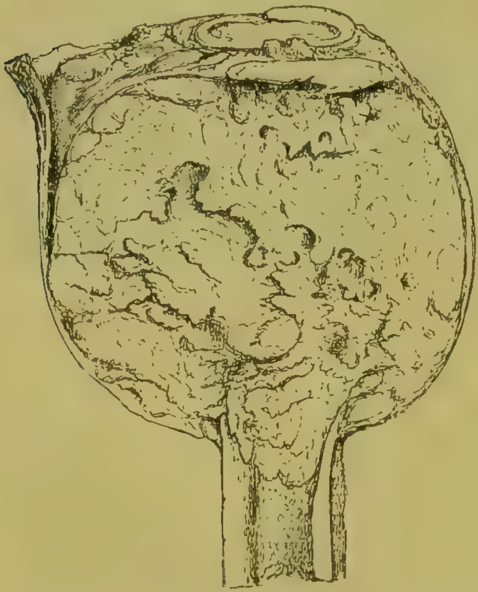

FIG. 173.—Central sarcoma of the upper end of the tibia. (From the Museum of St. George's Hospital.)

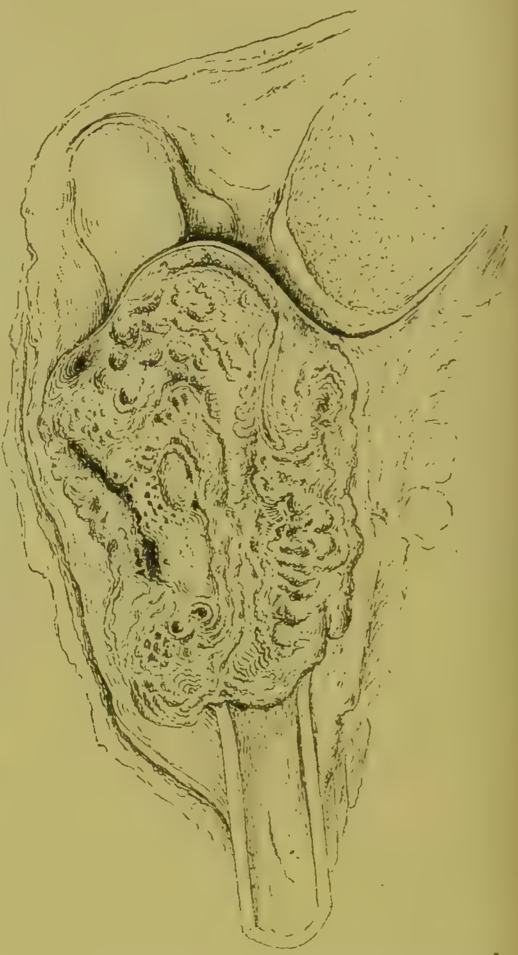

FIG. 174.—Myeloid sarcoma which has undergone degenerative changes. (From a drawing in the Museum of St. George's Hospital.)

have a greater tendency to diffuse themselves widely in the medullary tissue, and are much more malignant than the myeloid tumour. The favourite seat of the central sarcomata is the articular extremities of the long bones, and some bones are more prone to be affected than others, the lower end of the femur and the upper end of the tibia being the two places where the disease is most commonly situated. The disease most frequently occurs at about early middle life, but no age can be said to be exempt from it.

The central sarcomata are more liable to undergo degenerative than developmental changes, and myxomatous, cystic, and fatty degenerations are commonly present in these tumours (fig. 174).

Symptoms.—The early signs of this condition are a fixed and constant pain in the end of one of the long bones, which is worse at night and is accompanied by slight enlargement; so that the disease at its commencement is not to be distinguished from chronic ostitis. The steady, progressive, and somewhat rapid increase in the size of the bone should put the surgeon on his guard. In some cases there is conjoined with the enlargement of the bone a little effusion into the neighbouring joint. But the growth, as a rule, does not implicate the joint, but is arrested by the articular cartilage. Later on as the swelling increases the bone over it becomes so thinned that it communicates a peculiar crackling sensation to the fingers, which is known under the name of *egg-shell crackling*. There are no signs of inflammation; the skin is white and glossy, with very often a number of large veins visible in the subcutaneous tissue. Not uncommonly, on account of the great vascularity of these tumours, a distinct pulsation can be felt and sometimes a bruit heard. When the tumour extends beyond the osseous limits it begins to increase much more rapidly, and may attain a very considerable size. After the bone has been thinned by the disease, spontaneous fracture is likely to occur, and sometimes this fracture is the first indication of the disease, especially if the tumour is a rapidly growing one. The myeloid tumour of bone is very much less malignant in character than the round- or spindle-celled sarcoma, and rarely gives rise to secondary growths, and very often does not recur if entirely removed.

Peripheral or **periosteal sarcoma** (fig. 175) grows for the most part from the surface of the bone, beneath the periosteum, though there is a rare variety, termed *parosteal*, which grows from the tissues outside the periosteum and secondarily invades the bone. The periosteal sarcomata are spindle- or round-celled, or more frequently a combination of the two. They usually commence on one side of the bone, but may subsequently surround it. They are very prone to undergo developmental changes, and to undergo ossification or chondrification. In this way the bulk of some of these tumours may consist of bone, clothed by a thin coating of sarcomatous tissue. The new-formed

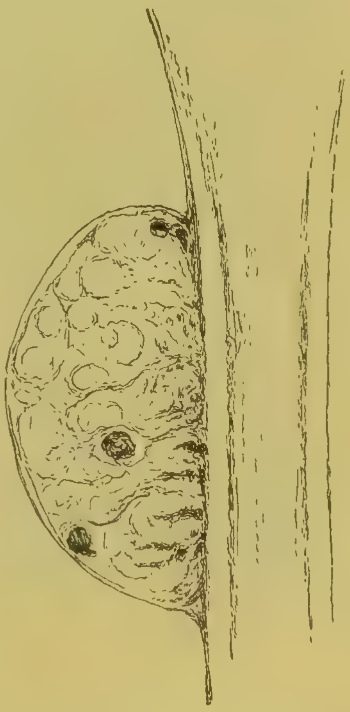

FIG. 175.—Peripheral sarcoma of the tibia. (From a preparation in the Museum of St. George's Hospital.)

bone is spongy and porous, and the trabeculæ of which it is composed have a radiate direction from the surface of bone from which it grows. When these tumours do not ossify they erode the bone and may lead to spontaneous fracture.

Symptoms.—The signs of the periosteal sarcoma are the presence of a tumour, which is fixed to the bone. It has a rounded and definite margin, may be either smooth or tuberous on its surface, and is of varying consistency, sometimes being yielding and elastic, at others presenting a hard and unyielding centre. The disease may be mistaken for a periosteal node, but its rapid and uniform increase, without any signs of inflammation, will determine the diagnosis. Skiagraphy may be of use in determining the nature of the disease, as in the case from which fig. 176 was taken, which was one of peripheral sarcoma of the femur, which was detected at a very early stage by this means. It will be seen that the deeper parts of the growth are much darker, because here the tumour had undergone ossification. Peripheral sarcomata are very much more malignant than the central ones. They grow more rapidly, they show a much greater tendency to recur locally after removal, and there is frequently a deposit of the same growth in distant organs. The usual method of dissemination is by the veins.

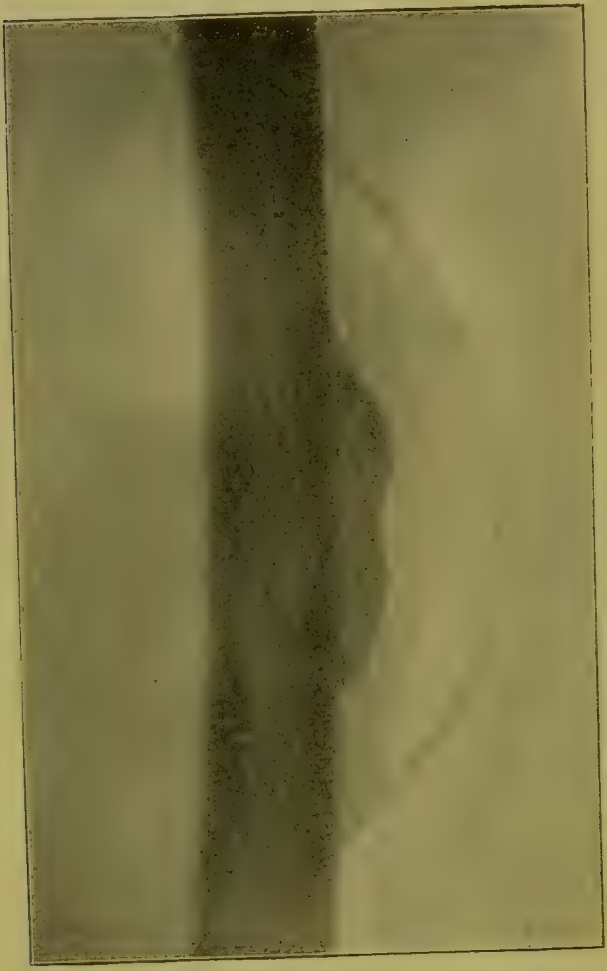

FIG. 176.—Skiagraph of a peripheral sarcoma of the femur. (By Mr. J. H. Montague.)

Diagnosis.—It is of great importance to distinguish clinically between the peripheral and central sarcomata, as the treatment of the two conditions is very different, at all events when the central tumour is myeloid in its nature. The central tumours are spherical in outline, are preceded by an aching pain in the part, generally occur at the ends of a long bone, and are surrounded by a hard bony casing, in which after a time a soft spot appears, and when it does so the pain is usually very much mitigated. The peripheral tumours, on the other hand, are long and fusiform, often connected with the shaft of a long bone, not often accompanied by pulsation, and not presenting the same bony hardness on the surface, though it may have a hard and unyielding centre.

Treatment.—The only possible treatment is by operation, but the nature of the operation must vary according to the variety of the disease which is present. If the disease is myeloid, all that is necessary is to remove the portion of bone from which the tumour grows. In the upper extremity this can often be done by excising a portion of the bone and not removing the whole. Thus in a central sarcoma of the upper end of the humerus, the head of the bone and if necessary a small portion of the shaft may be removed, and a very useful member left; or in myeloid tumour of the lower jaw it is usually sufficient to remove half or even less than half of the bone. But when the disease occurs in the lower extremity, it is probably better to amputate just above the growth, for the limb which would be left after such an extensive excision of bone as would be necessary would scarcely be available for purposes of progression. If the disease is.peripheral, or central of any other kind than myeloid, the whole bone from which the disease springs should be removed. Perhaps there is one exception to this rule; in peripheral sarcoma of the lower end of the femur, if this rule were followed out, amputation at the hip joint would have to be performed; but the mortality after this operation is so high that it is judged better to amputate a little below the trochanters provided that plenty of room can be obtained for fashioning the flaps in tissues free from any infiltration.

Secondary sarcoma of bone is occasionally met with, perhaps most frequently in cases of melanotic sarcoma, though it is occasionally found in cases of other forms of sarcomatous tumour. It is most commonly central, and may lead to fracture. No operative interference is, as a rule, permissible in these cases on account of the general infection of the system.

Carcinoma of bone is always secondary, and as such is by no means uncommon. Cancer of the breast most frequently gives rise to this condition, and it is usually endosteal in character and gives rise to persistent pain, and is often followed by fracture.

Epithelioma of bone, due to direct extension from epithelioma of the soft parts in the neighbourhood, is also not uncommon. This condition we find in the tibia, as the direct extension of the disease from an old ulcer of the leg which has become epitheliomatous; or in the lower jaw in cases of cancer of the lip or tongue. Another form of secondary cancer of bone follows cancer of the thyroid body; the chief characteristic of this form is its great vascularity, which causes it to pulsate strongly.

Pulsating tumours of bone.—The term *osteo-aneurism* was formerly applied to all tumours of bone which pulsated. It is now known that the great majority of these are very vascular sarcomata, which pulsate on account of the large number of new vessels or channels which they contain. In addition to these there are, however, two other classes of cases of pulsating tumour of bone, the exact pathology of which is still uncertain. (1) In one of these there is a vascular erectile tumour, practically identical with what has already been described as aneurism by anastomosis, which grows in the interior of bone, most frequently within the flat bones of the skull, and consists of a collection of dilated vessels massed together in a hollow cavity formed in the bone. The shell of bone forming the wall of this cavity is very thin, so that egg-shell crackling may be detected, and after a time the bone is often completely absorbed on one side, so that the tumour grows into the soft parts. These tumours have a distinct pulsation, and after they have perforated the bone they present the symptoms of aneurism by anastomosis, and differ from it only in the fact that they are partly lodged in the bone. (2) The other form of erectile tumour of bone consists of a cavity, generally hollowed out in the cancellous tissue of the ends of the long bones and containing blood. The bones forming the wall of this cavity are often a mere shell (fig. 177), and a very forcible pulsation may be communicated through it to the hand placed upon the enlarged end of the bone. It seems most probable, as first pointed out by Volkmann, that these are merely sarcomatous blood-cysts, composed of a thin envelope of sarcomatous tissue around a central mass of blood, and probably formed by an effusion of blood into a sarcoma, which becomes expanded over the collection of blood and forms a sort of cyst to it. In these cases the symptoms are the same as in a pulsating sarcoma, though as a rule no bruit is present. The diagnosis between the two conditions is impossible, but this is of little moment, as the treatment of the two is the same.

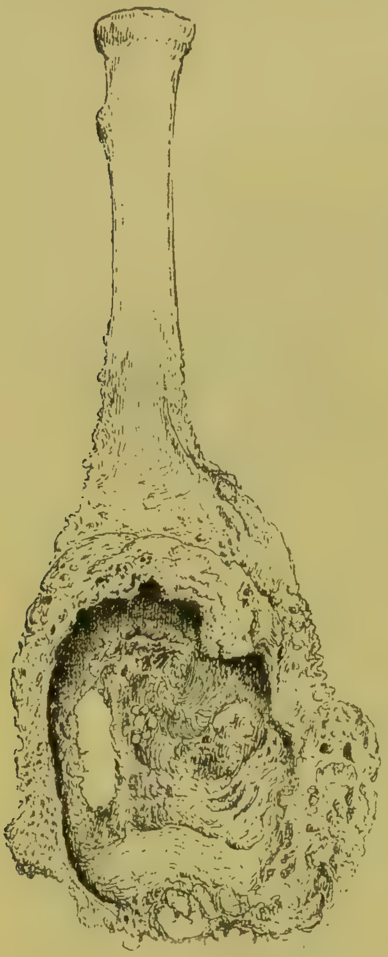

FIG. 177.—Cystic expansion of the lower end of the radius ('spina ventosa' of the old authors), probably the result of a growth of sarcoma in the centre of the bone. (From the Museum of St. George's Hospital.)

Treatment.—When a pulsating tumour of bone occurs on one of the extremities, the part should be rendered bloodless and a free incision made into the tumour for the purpose of ascertaining the exact nature of the case. If it turns out to be an undoubted sarcoma, amputation should at once be performed. If it consists of blood with a thin envelope of sarcomatous material, it is proper to scrape the bony cavity thoroughly, so as to get rid of the envelope, and then pack it from the bottom with gauze. When the tumour occurs in the bones of the skull, probably the wiser course is not to undertake any operative interference.

Cystic tumours of bone.—Cystic tumours of bone are rare, except those connected with the jaws, which will be described with diseases of the face. Almost the only form of cystic tumour which is found in other bones is the hydatid tumour, if we except cysts in tumours; that is to say, where other tumours of bone, such as the chondromata and sarcomata, have undergone cystic degeneration and formed cavities in their interior. They differ in no respect from cysts in tumours found elsewhere, and require no further description.

Hydatids of bone.—Occasionally, but rarely, hydatid tumours develop in the cancellous tissue or in the medullary canal of the long bones. They cause expansion of the bone, which forms a thin shell around it. This may sometimes give way under a slight degree of violence, and spontaneous fracture result. They give rise to the symptoms of an ordinary endosteal tumour, with, later on, the presence of egg-shell crackling.

and can scarcely be diagnosed from other forms of endosteal tumour of bone, except by exploratory puncture, when the character of the fluid withdrawn will at once determine the nature of the case.

Treatment.—An attempt should be made, if the disease has not encroached too extensively on the bony tissue, to save the limb by laying open the cyst, scraping out its contents, and allowing it to granulate from the bottom. With careful antiseptic precautions such a case may be expected to do well; but where the disease is very extensive, and has involved the bone to a very considerable extent, amputation may be called for.

CHAPTER VI

INJURIES AND DISEASES OF JOINTS

INJURIES

Contusions.—Joints are often contused by direct violence, such as falls, blows, or kicks. The injury is attended by an effusion of blood into the cavity of the joint if the synovial membrane has been torn, and by consecutive inflammation of the structures entering into the formation of the articulation.

Symptoms.—In some cases there is little to mark the injury beyond the history of the accident and pain, greatly increased on moving the joint, with some little tumefaction; but in other cases, where blood has been effused into the joint (*hæmarthrosis*) or into the tissues around, there is rapid swelling and discolouration. Later on, the swelling may be increased by the effusion of synovia. The blood and the synovia undergo absorption after a time, and as a rule no untoward results follow. In the young, however, and especially in tuberculous children, these injuries should never be lightly treated, as they may be and often are the starting point of serious tuberculous disease of the articulation.

Treatment.—The treatment consists in perfect rest and the maintenance of complete immobility of the joint by the application of a splint. The limb should be raised, and cold applied by means of ice, Leiter's tubes, or evaporating lotions. If the joint is so much distended with fluid as to cause severe pain and tension, it may be relieved by aspiration.

Sprains.—By the term *sprain* we mean a violent twisting or wrenching of a joint so that its ligamentous structures are either much stretched or partially torn, though there is no displacement of the bony surfaces from each other. The amount of injury which takes place varies in different cases: in some there is merely a laceration of a few ligamentous fibres; in others ligaments may be completely torn across, or, what is more common, scales of bone to which the ligaments are attached may be broken off, constituting *sprain fractures*; surrounding tendons may be displaced from their grooves; or muscles and tendons may be torn: the synovial membrane and capsule may be lacerated, and there may be a considerable extravasation of blood.

Symptoms.—The immediate effect of a sprain is a very severe, sickening pain. This is followed by swelling, due in the first instance to the blood which has been extravasated, subsequently to effusion of inflammatory products. There is inability to bear any weight on the injured limb, and any attempt to move the joint is attended by increased pain. The amount of pain and swelling will depend upon the severity of the lesion. The **diagnosis** of these cases from fracture and dislocation is not always easy.

On account of the swelling, and the pain which is produced by manipulation, a fracture or displacement may very easily be overlooked, or, in the young, a separation of the epiphysis. The greatest care should therefore be exercised, and if there is any doubt a most rigid comparison of the relation of the bony prominences to each other should be instituted; and if the diagnosis cannot be satisfactorily made out, a skiagraph of the injured part should be at once obtained.

Effects.—As the inflammation which has been set up subsides, there is often pain and stiffness in using the part, which may continue for some time and may leave permanent stiffness or even ankylosis, from fibrous adhesions having formed in the sheaths of the tendons and in the joint, or from contraction of the capsular and other ligaments. In some constitutional conditions, as the rheumatic or tuberculous, the subsequent inflammation may assume the characteristic type of these conditions. The joints which are the most frequently sprained are the ankle, the knee, and the wrist.

Treatment.—The treatment of sprains, until recently, has been of a most unsatisfactory nature, and has often resulted in impaired movement of the joint and brought discredit on the surgeon. Since, however, the introduction of the treatment by massage, it is remarkable how quickly the pain and swelling disappear and the patient recovers from his injury. The treatment is very simple. As soon as the patient is seen—it may be an hour or so after the injury—massage is at once commenced. The limb, resting on a pillow, is gently stroked in an upward direction, and in the course of five minutes or so the patient will begin to experience relief from his pain. If the sprain is in the ankle he should now be encouraged to move his toes; if in the wrist his fingers, the massage still being continued. In about a quarter of an hour the pain will probably have almost, if not quite, disappeared, and the patient must be induced to try and move the injured joint. This he will probably be able to do. Twenty minutes will generally be found long enough for the first massage. The limb should now be fixed on a splint and raised, and the patient left. The same proceeding must be repeated every day, the time of the application of the massage being prolonged to half an hour; and in the course of a few days the patient should be encouraged to put his foot to the ground and walk. In about a week, in most cases, he will be able to walk without pain or weakness, and there will be no subsequent stiffness or rigidity. The old plan of treating sprains consisted in keeping the injured limb fixed on a splint until all pain and swelling had disappeared, and then employing passive motion and massage. Sir James Paget has drawn attention to the evils of this mode of treatment. 'Too long rest is, I believe, by far the most frequent cause of delayed recovery after injuries of the joint in nearly all persons who are not of a scrofulous constitution. In the healthy, the chronic rheumatic, and the gouty, it is alike mischievous.'[1]

Wounds of joints.—These are always serious injuries, and under certain circumstances may be peculiarly dangerous ones, the great danger depending upon the introduction of some septic material. If a perfectly clean, aseptic cut be made into a joint, as in an operation for removal of a loose body, and the case is properly treated afterwards, the wound heals without any local trouble or constitutional disturbance; but if the wound is made with a septic knife, or any septic material gains access to the joint after its infliction, acute infective arthritis is set up, which unless vigorously treated may result in the loss of the limb or the life of the patient.

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[1] *Clinical Lectures*, p. 96.

Pathology.—In favourable cases—that is to say, in aseptic cases—beyond a little transient effusion, which is soon absorbed, there is nothing to note. The wound heals by first intention, and the movements of the joint are soon restored. But if any septic material has been introduced, the joint speedily becomes filled with fluid, which is turbid in character and consists of synovia mixed with the products of inflammation, and presents, on microscopic examination, micro-organisms. The synovial membrane becomes intensely injected, soon loses its natural lustre, and in the course of a few days is converted into granulation tissue. The fluid in the joint, at first turbid, becomes thicker and thicker, flakes of lymph will be found floating in it, and it soon presents all the characters of pus. The ligaments become involved, and are swollen and softened. The cartilages lose their natural lustrous appearance and become opaque and yellow and then eroded, and the articular ends of the bones become exposed and superficially ulcerated. The inflammation extends to the structures outside the joint, which become infiltrated with inflammatory products. Eventually the whole of the structures of the joint—the synovial membrane, the ligaments, the cartilages, and the articular lamella of bone—become destroyed and replaced by granulation tissue, and the cavity of the joint filled with pus. If the patient's strength has survived this protracted destruction, the pus having found its way to the surface and been discharged, a reparative process sets in. The superficial part of the granulation tissue which now lines the cavity, which was once the joint, perishes and disintegrates from malnutrition ; while the deeper layers, being nearer the blood supply, undergo developmental processes and become converted into first fibrous tissue, and then, where it is situated between the opposing osseous surfaces, into bone, so that a complete synostosis takes place ; the granulation tissue around the site of the joint forming a dense fibrous cicatrix.

Symptoms.—If the wound is large, so that the articular surfaces are exposed and can be seen, there is no difficulty in arriving at a conclusion as to whether a joint has been opened or not. But when the wound is a small punctured one, the exact nature of the injury is not so evident, especially if the wound is situated some little distance from the joint and is oblique in direction. The presence of a drop of synovia exuding from the wound is an indication, when present, that the joint has been opened. An exact history of the manner in which the accident happened, the position of the patient and the instrument at the moment of infliction, and the length of the instrument, will be some guide to the surgeon in coming to a conclusion. On no account should the wound be probed : for if it is it may have the effect of completing the perforation into the articular cavity which did not, perchance, previously exist. If the injury has been inflicted by a presumably aseptic instrument, the skin around should be cleansed and the wound treated antiseptically, and the result waited for. If the instrument is known to be septic, it is wiser to enlarge the wound, ascertain by ocular demonstration whether the joint has been opened, and proceed accordingly. If in the case of a wound of a joint acute septic arthritis is set up, within a few hours the joint becomes greatly swollen and severe lancinating pain is experienced. The swelling at first assumes the shape of the synovial sac, but after a time the tissues outside the joint are involved in the inflammation, and the swelling becomes more globular. The skin is red and hot. As suppuration sets in, the redness becomes more dusky; œdema of the soft parts over the joint is present; the pain is of a tensive throbbing character, and there is constant starting of the limb at night. As soon as the patient drops off to sleep, the muscles are relaxed, the articular surfaces move on each other, and this is attended by an intense pain, and the patient awakes with a start and a sharp cry of pain. This prevents sleep or rest. The constitutional symptoms are very severe. The temperature is high, there is great febrile excitement, and the patient rapidly emaciates and 'goes downhill.' About the tenth day, when granulations have formed and act as a barrier to further septic absorption, the febrile symptoms often very considerably abate, and the temperature becomes lower. Later on, after the pus has discharged itself, the fever assumes a hectic type. In some cases the patient may die from pyæmia, or later on from exhaustion.

Treatment.—In determining the treatment which should be adopted in a case of wound of a joint, much will depend upon the amount of injury which has been inflicted. In extensive injuries with much comminution of the bone, as in those injuries produced by gunshot wounds, it may be necessary to perform primary excision. In determining this point, it should be borne in mind that injuries of the joints of the upper extremity, with perhaps the exception of the wrist, do better after excision than injuries of the joints of the lower extremity. The size of the articulation, the age and the constitutional condition of the patient, are also points which should have due consideration. If it is not thought necessary to resort to operative interference, the treatment will depend to a great extent upon the size of the wound. If the joint is freely opened and the articular surfaces exposed, the patient should be placed under an anæsthetic and a thorough cleansing of the joint instituted. The skin around the wound, and the edges of the wound itself, should be thoroughly scrubbed with a nail-brush and well sluiced with corrosive sublimate solution (1 in 1,000). The joint must be irrigated with hot corrosive sublimate (1 in 2,000) until every particle of foreign matter and blood clot is got rid of. In doing this, too much care cannot be bestowed; every recess must be thoroughly flushed, and if this cannot be done in consequence of the size or position of the wound it must be enlarged. After the cleansing process has been completed, a drainage tube should be inserted in the most dependent position, and unless the edges of the wound are very much ragged and torn they should be sutured. In doing this, care must be taken to bring the edges of the synovial membrane into apposition. A needle, armed with silkworm gut which has been well soaked, should be passed through the superficial parts, the capsule, and the synovial membrane on either side, and tied, and this is done until the whole wound, except the opening for the tube, is sutured. In cases where the superficial parts of the wound are much bruised, but the edges of the wound in the synovial membrane are fairly clean, it may be worth while to bring them together with a catgut suture in the hope that they will unite. After the wound is closed it must be dressed and immobilised on a splint. The temperature should be taken every four hours, and if it remains normal the tube should be withdrawn at the end of the second day.

If the wound is a small punctured one, the treatment must depend upon the evidence which can be obtained as to the aseptic condition of the instrument which produced it. If there is fair ground for assuming that the instrument was clean, the treatment must consist in perfectly cleansing the parts around, sewing up the wound if it is sufficiently large to require it, dressing antiseptically, and maintaining the part at absolute rest. But if the instrument is known to be septic—a butcher, for instance, letting his knife slip when cutting up meat, and wounding his knee-joint—the safer plan is to freely enlarge the wound, wash out the joint, and then suture the wound, bringing the synovial edges into contact.

If acute septic arthritis sets in after a wound of a joint, the whole joint must be freely exposed by two lateral incisions, or by a horseshoe-shaped incision, and thoroughly irrigated. Drainage tubes must then be inserted, and the case treated with the greatest antiseptic care. In this way, especially in young persons, the integrity of the joint may be preserved.

DISLOCATIONS

By the term **dislocation** is meant the displacement of the articular surfaces of a joint from their normal relation to each other. This displacement may occur in three different ways as regards its cause. (1) The articular surfaces may be displaced from each other by violence: *traumatic* dislocation. (2) They may be displaced from each other as the result of some destructive change taking place in the joint or surrounding structures, so that the bony surfaces can no longer be retained in apposition, but are displaced in consequence of muscular contraction or the weight of the limb or trunk: *pathological* dislocation. (3) There may be some congenital defect or malformation of the joint, so that the bony elements entering into the formation of the joint do not bear their normal relationship to each other. This is termed a *congenital* dislocation.

TRAUMATIC DISLOCATIONS

A dislocation may be either partial or complete: *partial*, when the articular surfaces are displaced as regards their normal position to each other, but are not completely separated; *complete*, when there is an entire separation of the two surfaces from each other. A dislocation may be also simple and compound: *simple*, where there is no wound communicating with the joint; and *compound*, where there is.

Causes.—There are certain factors which must be looked upon as *predisposing causes* of dislocation, and amongst these the principal are: (1) the nature of the joint; (2) the situation of the joint; (3) the age and (4) the sex of the patient. (1) The *nature of the joint.*—This is the most important of all the predisposing causes, and the general rule may be laid down that the greater the freedom of movement there is in a joint, the greater liability there will be to dislocation. The ball-and-socket joints enjoy a greater range of movement than any others, and, all other things being equal, are in consequence more liable to become displaced. The shoulder joint has a greater range of movement than the hip, and one of the reasons of the liability of this articulation to dislocation is the freedom of movement which it enjoys. (2) The *situation of the joint.*—Some joints are more exposed to violence than others, and therefore more frequently dislocated. (3) The *age of the patient.*—Dislocations generally occur in adults or middle-aged people, and are rare in children (with the exception of those of the elbow joint) and in old people. (4) The *sex.*—As would naturally be supposed, dislocations are more common in the male than the female, on account of their greater exposure to accidents.

The **exciting causes** of dislocation are either mechanical violence or muscular action. Mechanical violence may act in two ways, either directly or indirectly. A direct blow on a joint may drive one bone directly away from the other. Indirectly a dislocation may be produced by a fall or blow on one end of a bone, driving the other away from the articular surface with which it is in contact.

Effects.—When a dislocation takes place, there is more or less injury to the parts in and around the joint. The ligaments, which bind the bones together, are always to a certain extent torn in a complete dislocation. The bones are frequently fractured, as well as displaced, and this is especially likely to occur in hinge joints. The amount of fracture may vary from chipping off of a fragment to extensive comminution. The muscles which surround the joint are often bruised and torn, and the cartilages may be injured. Vessels and nerves may be compressed by the displaced bone and sometimes lacerated. Considerable extravasation of blood is always present, producing great swelling and bruising around. If the dislocation is speedily reduced, these injuries are soon recovered from and the functions of the joint are not usually interfered with, though cicatricial contraction of the injured structures may prevent a full range of movement for some considerable time—perhaps permanently.

Symptoms.—The signs by which a dislocation may be recognised are: (1) pain, following an injury, and usually of a severe and sickening character; (2) swelling and deformity about the joint; (3) alteration in the relative position of the bony prominences in the neighbourhood of the joint to each other, as compared with those on the opposite side of the body; (4) impaired mobility, both active and passive: but with regard to this sign it must be borne in mind that a fracture may exist with the dislocation, under which circumstance the mobility may be increased: (5) the displaced end of the bone or bones can generally be felt in a new position; (6) there is an alteration in the length of the limb, sometimes lengthening and sometimes shortening; and (7) there is an alteration in the direction of the axis of the limb.

Diagnosis.—Dislocations are liable to be mistaken for fractures in the neighbourhood of joints, but there are three points of distinction between the two injuries. In dislocation the mobility is impaired: in fracture it is increased; in dislocation there is no crepitus: in fracture crepitus can, as a rule, be elicited; in dislocation, when the deformity is reduced, it does not generally recur: in fracture it does. There are, however, some exceptions to this rule.

Treatment.—The treatment of a dislocation consists in the first place in reducing the deformity and returning the displaced bone to its normal position. This should be done as soon as possible, and if a patient is seen immediately after the accident, while he is faint and his muscles relaxed, it can generally be done with ease; but if some time has elapsed, muscular tension becomes so great that an anæsthetic is usually necessary.

There are two principal modes of reducing a dislocation, viz. by manipulation and by extension.

Manipulation is always the best way to reduce a dislocation, if possible, and should be tried first, because there is less danger of doing injury to surrounding parts. It aims at making the displaced end of the bone retrace the steps by which it has become dislocated, by executing certain movements of the limb. These movements are conducted in such a manner that they shall relax untorn ligaments, bring the end of the bone opposite the rent in the capsule, and in some instances, by employing a ligament which is still intact as a fulcrum, levering the head of the bone back into its socket. The special manipulations required will be described in dealing with individual dislocations.

Extension has for its object the overcoming of muscular resistance and other impediments to reduction, by a superior force; and by the application of extension to the limb to forcibly drag the bone back into its normal position. In order to do this effectually, *counter extension* has first to be made, generally by an assistant. Extension is made by the hands of the surgeon grasping the limb below the seat of dislocation; or, if greater force is required, by a bandage or jack-towel fastened to the limb by a clove-hitch knot. Formerly, multiplying pulleys were much employed as a means of making extension, but they are rarely if ever used in the present day.

The extension should be steady and continuous, and not made in jerks; and combined with it a slight lateral or rocking movement may be given to the dislocated bone, which will assist in freeing the extremity and facilitating reduction. Reduction is generally attended with a distinct and audible snap, and the patient, if not under the influence of an anæsthetic, will often be conscious that the head of the bone has returned to its normal position.

After the dislocation has been reduced, the part should be supported in a convenient and comfortable position on a pillow or cushion, and massage at once commenced by gently stroking the parts with the palm of the hand in the course of the venous circulation. This must be done extremely lightly so as not to cause pain; in fact, if the patient has not been anæsthetised or has recovered from his anæsthetic, he ought to experience relief from the rubbing. At the first sitting this may be continued for fifteen or twenty minutes, and the limb is then to be put on a splint, or bandaged in such a way as to prevent any movement. Each day the bandages and splints are to be removed and massage employed for half an hour; and at the end of a week, passive motion is to be commenced, at first gently and cautiously. In three weeks or a month the patient may be allowed to move his limb.

Unreduced dislocations.—If a dislocation is allowed to remain unreduced, great and important changes take place. The muscles and ligamentous structures around the joint become infiltrated with a dense cicatricial material and shortened, so that reduction is impossible without division or rupture of these structures. The head of the displaced bone becomes denuded of cartilage and altered in shape; the structures against which it rests, by pressure and absorption, are hollowed out into a cavity, which is lined with a dense fibroid material. Around this a sort of spurious capsule forms from the organisation of inflammatory exudation, and this holds the bone in its new position; and in some instances a bursal sac develops between the head of the bone and the tissues against which it rests. In this way a fairly formed false joint may result (fig. 178). The old cavity from which the head of the bone has been displaced usually becomes filled up with dense fibroid material and obliterated. The vessels and nerves in the neighbourhood may become fixed to the capsule by adhesions.

The amount of movement which can be obtained in a false joint varies very considerably, depending partly on the amount of injury which has been done to the soft parts around and the consequent inflammatory thickening and consolidation which has taken place, and partly upon the nature of the joint; very much more movement, as a rule, being obtainable in a ball-and-socket joint than in a hinge joint. Upon the amount of movement which can be obtained without pain will, in a great measure, depend the decision of the surgeon as to whether any attempt should be made to reduce the dislocation. The old rule laid down by Sir Astley Cooper that it was improper to attempt the reduction of an old dislocation of the shoulder of more than three months' standing, or a dislocation of the hip of more than two months, does not now hold good. Owing to the introduction of anæsthetics, attempts have been successfully made to reduce dislocations of much older standing than this. At the same time it must be borne in mind that these attempts cannot be made without incurring a very considerable amount of risk. Instances are by no means uncommon where very serious injury has been done by an attempt to reduce an old-standing dislocation: large blood-vessels and nerves have been torn; bones have been broken; the skin and muscles have been lacerated, and inflammation and suppuration have been set up. It therefore behoves the surgeon to consider every case on its own merits, and determine whether he shall attempt reduction; taking into consideration the amount of movement which the patient has in the limb with the bone in its new position. If he can move the parts without pain and with a fair amount of freedom, probably the wiser course is to leave the parts alone if a longer period than three months has elapsed since the accident.

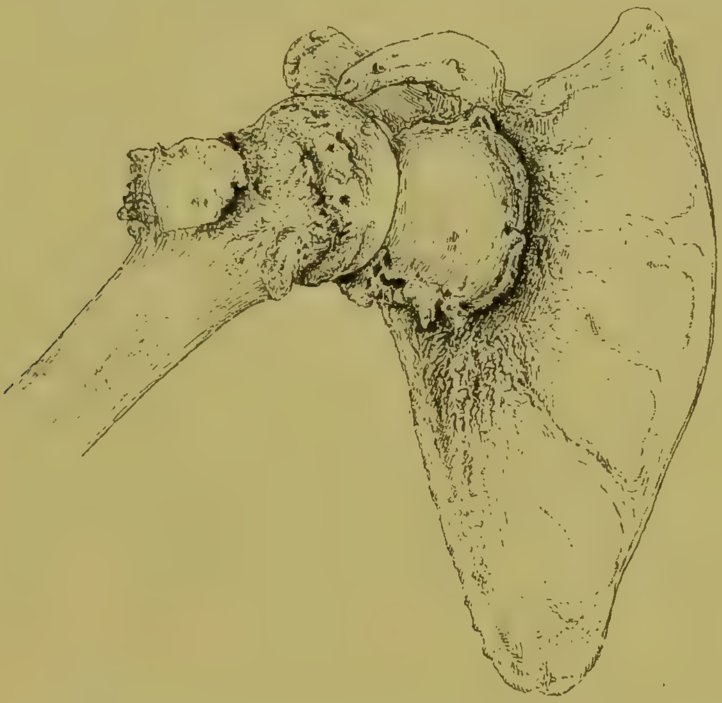


FIG. 178.—Unreduced dislocation of the humerus, showing the formation of a new cavity for the head of the bone, under the coracoid process. (From a preparation in the Museum of the Royal College of Surgeons.)

In attempting the reduction of an old-standing dislocation, all adhesions must first be thoroughly broken down, and then an effort made to replace the bone by manipulation or extension. In some cases of old unreduced dislocations, where attempts have been made to reduce it and have failed, or where it is judged not to be expedient to make these attempts, an open operation under strict antisepsis may be undertaken ; the displaced head of the bone may be cut down upon, all resistant structures thoroughly divided, and the head of the bone replaced or excised. Both methods give excellent results in cases of dislocation of the shoulder and elbow, to which this plan of treatment especially applies. The principal indication for its adoption is great pain, limited range of movement, and a wasted and atrophied limb.

Compound dislocations.—A compound dislocation is always a serious lesion; for there is a risk of septic contamination, as there is extensive laceration of the soft parts around the joint, which communicates with an open wound. In addition to this, important vessels and nerves in the neighbourhood are frequently injured, and the bones entering into the formation of the joint fractured. Unless efficient means are taken to render the parts aseptic, inflammation, running on to suppuration and complete destruction of the joint, ensues, and bony ankylosis is the most favourable result which can follow.

Treatment.—The first question to decide in undertaking the treatment of a compound dislocation is whether operative interference is necessary. In deciding the question many points have to be taken into consideration. In old and debilitated patients, or those whose constitutions are unsound, amputation may be indicated where the dislocation affects one of the large joints; and is required where the main vessels or nerves of the limb have been torn. If there is much injury to the soft parts around, or fracture of the bones, the question of excision versus amputation may arise. Dislocations of the upper extremity are particularly suited to excision, provided there is not *too great* laceration of the soft parts; whilst in the lower extremity, where a firm support to bear the weight of the trunk is required, the operation of excision is not so suitable.

If no operative interference is considered necessary, the most rigid cleansing of the parts is required. The dislocation must first be reduced, and then all the exposed and lacerated tissues thoroughly scrubbed with a strong antiseptic solution. A tooth-brush will be found to be a very convenient means of doing this ; it can be introduced into all the nooks and interstices of the wound, and the parts can be well scrubbed. If necessary, the wound must be enlarged to get at every part of the joint. One or more drainage tubes must then be inserted at the most dependent parts, and the case treated by the application of the principles of asepsis.

SPECIAL DISLOCATIONS

Under the head of special dislocations, we shall simply consider in this place dislocation of the bones of the two extremities, and reserve the consideration of the dislocations of the head and trunk for their appropriate chapters.

DISLOCATIONS OF THE UPPER EXTREMITY

Of the sterno-clavicular joint.—The clavicle may be dislocated from the sternum in three different directions : forwards, backwards, and upwards. The **cause** of these dislocations is nearly always violence applied to the acromial end of the bone ; and the variety of the displacement depends upon the direction in which the force is applied, and in which therefore the bone is driven. But in cases of injury to the acromial end of the clavicle the bone generally gives way and fracture occurs; and therefore, owing to this and to the great strength of the ligaments which bind the clavicle to the sternum, dislocation at this joint is very rare.

Dislocation forwards.—This is the most common form of dislocation at the sterno-clavicular joint, and occurs in those cases where the violence is applied rather to the front of the acromial end of the bone. The end of the bone is displaced forwards, inwards, and a little downwards, and rests on the front of the manubrium. The **signs** of the injury are very characteristic : the end of the bone can be felt as a rounded boss on the front of the sternum ; there is approximation of the shoulder to the middle line of the body, and great pain on movement. The only injury for which it may be mistaken is fracture of the sternal end of the clavicle ; but the absence of crepitus, and the rounded outline of the end of the bone, sufficiently indicate the nature of the lesion.

Treatment.—The dislocation can usually be easily reduced by placing the knee in the middle of the patient's back, between the two scapulæ, and drawing the shoulders forcibly backwards. After reduction, the end of the bone is very liable to slip out of place again, owing to the shape and different sizes of the two articular surfaces. To prevent this a figure-of-8 bandage should be applied over the two shoulders, crossing in the middle of the back ; a large pad should be placed in the axilla, and the arm bound to the side. For some time after the injury the patient should wear a truss, with the pad over the joint, so as to prevent a recurrence.

Dislocation backwards is caused by violence being applied to the back of the shoulder, so that it is driven forwards and inwards. It is said also to occur sometimes from direct blows on the sternal end of the bone. The articular end of the bone is displaced backwards and inwards and generally a little downwards, so that it rests behind the first piece of the sternum.

Signs.—There is a well-marked depression where the articular end of the bone ought to be. The shoulder is thrown forwards and approximated to the mesial line, and the head is inclined to the injured side. There may be dyspnœa from pressure on the trachea ; dysphagia from pressure on the œsophagus ; and congestion of the head and face, and perhaps even semi-coma, from pressure on the large veins at the root of the neck.

Treatment.—The dislocation can usually be reduced by the same method which was recommended in the dislocation forwards ; but a similar difficulty will be experienced in keeping the end of the bone in its place. To attain this object, a large pad or cushion should be placed between the shoulders, and they should be bandaged backwards over it by a figure-of-8 bandage. In cases where the bone cannot be kept in its place, and symptoms of dyspnœa, dysphagia, &c., are constantly recurring, it becomes necessary to excise the end of the clavicle.

Dislocation upwards is of extremely rare occurrence. It occurs when the violence to the acromial end is applied from above, so that this end of the clavicle is forced downwards and inwards. The dislocated end of the bone rests on the upper border of the sternum, in front of the trachea, and may press on this tube.

Signs.—The end of the bone is easily felt in front of the trachea. The axis of the clavicle is directed forwards and upwards, and there is approximation of the shoulder to the mesial line.

Treatment.—In order to effect reduction, a large and hard pad should be placed in the axilla to act as a fulcrum, and the elbow pressed well to the side. At the same time, pressure on the sternal end of the bone will facilitate reduction. The greatest difficulty will be experienced in maintaining the bone in its place, and some amount of displacement is almost sure to persist. The best means of retaining the bone in position is to place a pad in the back, as in the previous dislocation, with a figure-of-8 bandage over it. A pad, formed of folded lint, is then to be placed over the sternal end of the bone, and firmly secured in position by a broad and long piece of strapping placed over the pad ; one end is carried over the shoulder and down the back, and the other over the front of the chest of the patient, inclining to the sound side until the two ends meet over the outer side of the buttock.

Dislocation of the acromio-clavicular joint.—This dislocation is frequently termed dislocation of the *acromial end of the clavicle.* It is much more common than dislocation at the sterno-clavicular joint, and almost invariably occurs in one direction, the acromion process being displaced downwards and inwards under the outer end of the clavicle. It almost always occurs from violence applied to the back of the outer part of the scapula, driving the arch of the shoulder forwards.

Signs.—The dislocation is easily recognised by the projection of the outer end of the clavicle on the top of the upper surface of the acromion process. The shoulder is depressed and approximated to the mesial line of the body, and the patient is unable to raise the arm over the head.

Treatment.—Reduction can usually be easily effected by drawing the points of the shoulders backwards, but there is the greatest difficulty in maintaining the parts in apposition after reduction. The best way to do it is to place a pad over the joint, and firmly strap it in this position by a broad piece of plaister carried over the pad, down the back of the arm, under the olecranon process, the forearm being flexed, and up the front of the arm to the pad. The arm is then to be bound to the side. In most cases a certain amount of displacement persists, but beyond the deformity this is of little importance and does not impair the use of the arm. Should, however, *complete* displacement recur again and again, it will be necessary to expose the ends of the bones and peg or wire them together, after refreshing the articular surfaces.

Displacement of the scapula.—A peculiar deformity of the scapula, due to paralysis of the serratus magnus and rhomboid muscles, is sometimes described as *dislocation of the lower angle of the scapula.* One of the functions of the serratus magnus is to retain the scapula closely to the wall of the thorax, and to cause it to act as a fixed point when the deltoid raises the arm from the side. When the serratus magnus is paralysed, the lower angle of the scapula and its vertebral border are not held closely to the chest wall, but project unduly, and this projection is increased if any effort is made to raise the arm (fig. 179). The condition arises generally in cases of infantile paralysis, but may be due to nerve injury or neuritis.

The **treatment** consists in applying a belt round the upper part of the chest, with shoulder straps to retain it in position, and the application of massage and electricity to the paralysed muscles.

Dislocation of the shoulder.—Dislocation occurs much more frequently at the shoulder joint than at any other articulation. It has been computed that dislocation of the shoulder occurs as frequently as all the other dislocations in the body. This is due to the anatomical construction of the joint, and to the free range of movement that it enjoys, as well as its exposure to injury.

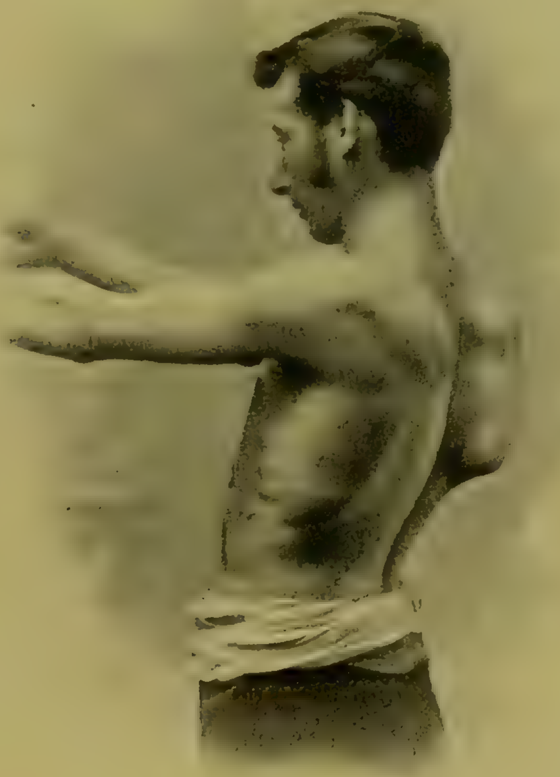


FIG. 179.—Paralysis of the serratus magnus muscle, showing the projection of the inferior angle of the scapula when the arm is raised. (From a photograph in the Museum of St. George's Hospital.)

Causes.—For the most part dislocations of the humerus are produced by force applied to the elbow or hand when the arm is abducted from the body, as in falls on the hand or elbow with the arm outstretched. When the limb is in this position, the head of the bone projects beyond the lowest point of the glenoid cavity and stretches the lower and inner part of the capsule, which is the weakest part; any force applied to the limb easily tears the ligament whilst in this state of tension, and the head is driven through the rent into the axilla, producing primarily a dislocation in which the head of the bone is displaced downwards into the axilla, and which is termed *sub-glenoid* dislocation. But as a rule the head of the bone does not stop there; but either from the force which has been applied, or from the violent spasmodic contraction of the muscles in the neighbourhood, the head of the bone is carried forwards or backwards into some new position. When it is carried forwards it may rest finally on the front of the neck of the scapula, beneath the coracoid process, when it is termed *sub-coracoid*; or it may be carried further and rest on the front of the chest, beneath the clavicle, when it is called *sub-clavicular* dislocation. When the head of the bone is carried backwards, it rests on the dorsum of the scapula, beneath the spine of this bone. This is the *sub-spinous* dislocation. Dislocations of the head of the humerus may also be caused by direct violence. A blow on the head of the bone may drive it either forwards or backwards, according as to whether the blow is given from in front or behind. The capsule is then ruptured at some other part than its weakest, and the primary displacement is in the direction in which the head of the bone is driven.

Symptoms.—The signs common to all dislocations of the humerus are: (1) pain and swelling, with bruising, about the part; (2) flattening of the shoulder; (3) apparent projection of the acromion process; (4) a hollow or depression beneath this process; (5) impaired mobility about the joint; and (6) the presence of the head of the bone in a new position. In addition to these signs which are common to all the dislocations, there is alteration in the length of the limb and in the direction of the axis of the humerus; these differ according to the position which the head of the bone occupies, and are principally useful as indicating the variety of the displacement. Certain special signs or indications have been laid down by different surgeons at different times, which may be found useful in cases of doubt. Callaway's test consists in taking the vertical circumference round the axilla, which is always increased in dislocation. Dugas' test consists in bringing the elbow in contact with the chest wall, and then seeing if the hand of the injured side can be placed on the sound shoulder. This, though the one most commonly employed, is the least reliable of these tests. Hamilton's test consists in laying a ruler along the outer side of the arm: if there is a dislocation the ruler can be made to touch both the acromion and external condyle of the humerus; this it will not do if the head is in its proper place.

Varieties.—As stated above, the principal varieties of dislocation of the humerus are four: (1) sub-glenoid; (2) sub-coracoid; (3) sub-clavicular; (4) sub-spinous; but to these must be added a fifth—which is, however, very rare—the supra-coracoid.

(1) **Sub-glenoid.**—In this dislocation the head of the bone is displaced downwards and a little forwards and inwards, so that it rests against the axillary border of the scapula, just below the glenoid cavity. It is not a very common form of dislocation, for though the head of the bone is primarily displaced into this position, it does not remain there, and therefore this dislocation is not commonly seen. The **signs** by which this variety of dislocation is distinguished from the others are that the head of the bone can be easily felt in the axilla; that there is considerable lowering of the anterior fold of the axilla, from the pectoralis major being drawn downwards at its attachment to the humerus; and that the arm is lengthened, and the direction of the axis of the humerus is outwards and slightly backwards.

(2) **Sub-coracoid** is by far the most common form of dislocation of the humerus that is met with. The head of the humerus lies on the front of the neck of the scapula, immediately beneath the coracoid process (fig. 180). The anatomical difference between this dislocation and the sub-glenoid is their relative position with regard to the subscapularis; in this dislocation the head lying above it, and in the sub-glenoid below it. It is frequently torn in both dislocations; but if it is not, in the sub-coracoid variety, it may prove a serious impediment to reduction, as it becomes stretched around the neck of the bone as a tense band. The **signs** by which this dislocation can be distinguished from the others are by the direction of the axis of the humerus, which is backwards and a little outwards, so that the elbow is directed slightly away from the trunk and behind it; by the abnormal position of the head of the bone, which can usually be felt beneath the coracoid process on rotating the arm, though sometimes in very stout people this is not always possible. There is not much alteration in the length of the limb; if anything, it is a little lengthened.

(3) **Sub-clavicular dislocation** is not at all common. It is an exaggerated form of the sub-coracoid variety; the head of the bone being driven further inwards and upwards, so that it rests on the second and third ribs, under the clavicular origin of the pectoralis major and immediately beneath the clavicle. There is never any difficulty in diagnosing this injury, as the head of the bone can be seen as a globular prominence under the pectoral muscle. The arm is distinctly shortened, and the elbow is carried outwards and backwards.

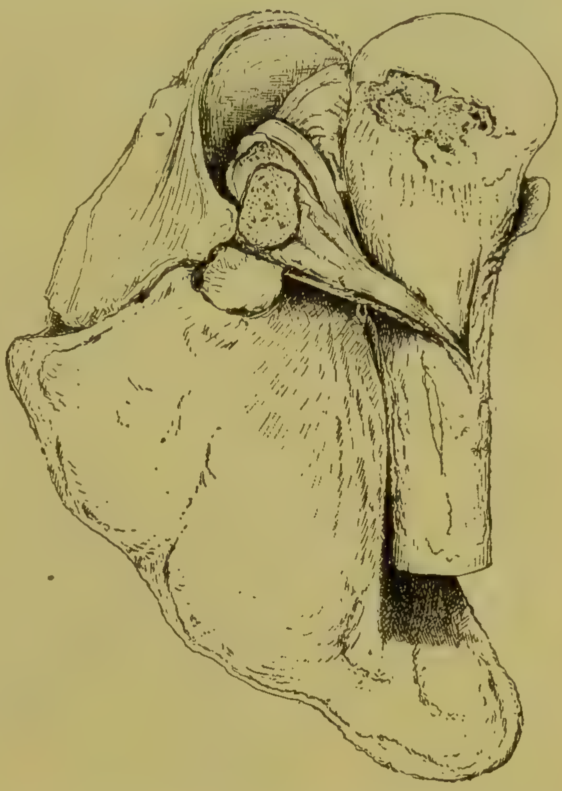


FIG. 180.—Dislocation of the shoulder joint, with avulsion of the greater tuberosity of the humerus. The head of the bone, which originally lay under the coracoid process, has been drawn outwards to show the fragment of the greater tuberosity. (From the Museum of St. George's Hospital.)

(4) The **sub-spinous dislocation** is not common. It would appear that when it does occur it is due to direct blows on the front of the head of the bone, driving it directly backwards. The displaced bone rests on the back of the scapula in the infra-spinous fossa, immediately beneath the spine. Malgaigne has described a less complete form where the head of the bone rests on the back of the neck of the glenoid fossa and under the acromial process (*sub-acromial*). The distinguishing **signs** of this dislocation are the direction of the axis of the humerus, the elbow being directed forwards and away from the side; and the presence of a rounded

prominence on the back of the scapula, beneath the spine. The arm is lengthened, and there is a distinct hollow or depression beneath the coracoid process.

(5) **Supra-coracoid dislocation.**—This must necessarily be attended with fracture of the coracoid process. The head of the bone rests between the fractured coracoid and the acromion, in contact with the anterior border of the clavicle. It is caused by direct violence applied in an upward direction. The injury can readily be diagnosed, for the head of the bone can be felt in its new position. It is easily reduced, but has a tendency to recur.

Treatment.—Dislocations of the shoulder joint may be reduced by manipulation or extension.

Manipulation.—This undoubtedly is the better plan of reducing dislocations of the shoulder, since the procedure can be carried out without any risk of injury. There is, however, a risk from the anæsthetic, which is almost essential in the reduction by manipulation, because the patient has not been properly prepared for it, and because deep anæsthesia is required. If, therefore, a patient is seen almost immediately after the accident, while he is still faint and collapsed, it is advisable to at first try reduction by extension, with the heel in the axilla, without an anæsthetic, and employing only a small amount of force. If an anæsthetic is judged to be necessary, then the plan by manipulation should first be tried.

The patient is to be laid flat on his back on a hard couch, and the proceedings should not be commenced until complete anæsthesia is obtained and the muscles are relaxed. The forearm is to be flexed on the arm, and the elbow brought down to the side: the surgeon then grasps the elbow with one hand and the wrist with the other, and rotates the arm outwards until a marked resistance is experienced. This untwists the capsule and renders the rent in it patent, and at the same time causes the head of the bone to roll outwards from beneath the coracoid. Sometimes this is all that is necessary; the head of the bone retraces its steps through the hole in the capsule, and the reduction is completed. If this is not so, the elbow is now to be moved forwards, upwards, and inwards, until it is opposite the middle line of the body, the external rotation still being maintained. This causes the head of the bone to glide over the edge of the glenoid fossa through the rent in the capsule. Thirdly, by rotating the arm inwards and carrying the hand towards the opposite shoulder, the head of the bone is forced into the socket, and the reduction is completed. The rules may be briefly summed up as follows: 1. Rotate arm outwards, with elbow flexed and close to chest wall. 2. Carry elbow to front of chest. 3. Rotate inwards and place hand on opposite shoulder. This plan, which was first recommended by Kocher, is the one almost universally adopted, and is particularly applicable to the common sub-coracoid dislocation; but it has also proved successful in the sub-glenoid dislocation, and may be tried in the sub-clavicular form. For the reduction of the sub-spinous dislocation, the surgeon stands behind the patient and grasps the shoulder, so that the thumb rests on the head of the bone and the fingers in front: with the other hand he seizes the arm near the elbow and raises it to a right angle with the trunk, at the same time making as much extension as he can. He now steadily circumducts outwards, and with his thumb presses on the head of the bone, so as to assist in pushing it into the socket. As soon as the head of the bone is felt to recede from under the thumb, the arm is to be brought down to the side.

Extension.—Many ways have been devised for overcoming the tension of the muscles and ligaments and reducing dislocations of the shoulder by extension. By far the best and simplest is by extension with the foot in the axilla. The patient is placed flat on a couch, and the surgeon, seated on the edge and facing the patient, places his unbooted foot in the axilla, so that the heel rests against the head of the bone. He now grasps the arm with both hands, and makes steady and forcible traction downwards and outwards. This generally succeeds in reducing the dislocation; should it not do so, while the extension is still kept up the arm is carried inwards; the heel then acts as the fulcrum of a lever of the first kind, and forces the head of the bone into the socket. Another plan is to place the knee in the axilla, instead of the heel, the patient being seated in a chair; but it is by no means so good. The knee is too large; the surgeon has not the same amount of extending force, and the position of the patient is an undesirable one for an anæsthetic. White of Manchester advocated vertical extension upwards. The patient is placed on a flat couch; the scapula is fixed by a jack-towel placed over the shoulder girdle, and held by an assistant standing at the foot of the bed, and the surgeon, standing behind the patient, pulls the arm vertically upwards. This plan has been modified by Lowe, who seats his patient on the floor, with his back to a couch or chair. The surgeon, standing on this, places his foot on the top of the shoulder girdle and pulls the arm directly upwards. The advantage of this plan is that it does away with the necessity of an assistant. But both methods are dangerous, as they expose the artery and vein to unnecessary risk. Sir Astley Cooper recommends placing the foot against the chest wall and making extension directly outwards.

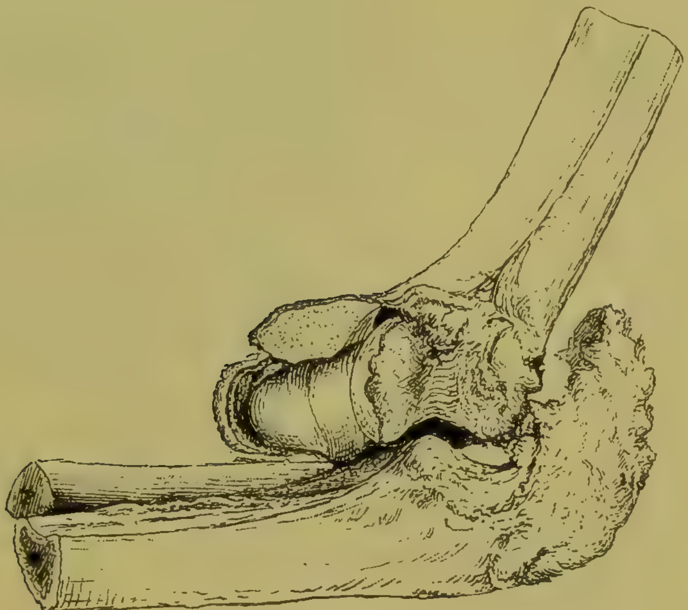


FIG. 181.—Dislocation of the elbow joint, with racture of the coronoid process. The head of the radius is also split. (From the Museum of St. George's Hospital.)

After reduction the plan of treatment indicated above by massage and passive movement must be sedulously carried out, or else permanent impairment of the movements of the articulation will very probably result.

In cases of old dislocations of the shoulder which cannot be reduced, an open operation, in which all the resisting structures are divided and the head of the bone replaced, has been attended with the most favourable results in modern surgery. And the question is one which should always present itself to the surgeon when called upon to treat such a case. The ones in which it is especially indicated are those in which the head of the bone presses on some of the nerves of the brachial plexus, causing great pain and loss of muscular power in the limb. The operation is by no means an easy one, for after division of all apparently resisting structures, it is still sometimes impossible to effect reduction. Under these circumstances the head of the bone should be removed.

Dislocation of the elbow joint is by no means uncommon, and is peculiar inasmuch as it frequently occurs in young children, on account of the small size of the coronoid process; whereas dislocation of any other joint is very uncommon, the bones more usually fracturing upon the application of any violence. The dislocations at this articulation may be either dislocation of both bones of the forearm or of one bone only.

Dislocation of both radius and ulna may take place either backwards, forwards, or to either side.

Dislocation backwards is by far the most common, and is generally produced by falls on the palm of the hand with the forearm extended. It is usually unattended with any fracture, but in some cases the coronoid process is broken off (fig. 181). When this is so, there is great liability for the dislocation to recur after reduction. In the complete form of the dislocation the bones of the forearm are displaced backwards, so that the coronoid process is lodged in the olecranon fossa (fig. 182); but in many cases the displacement is not so great, and then the coronoid process rests against the trochlear surface of the humerus.

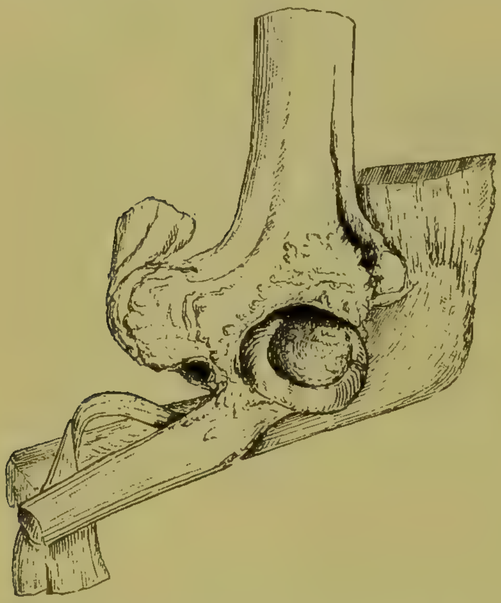


FIG. 182.—Dislocation backwards of the elbow joint. The head of the radius is lodged at the back of the external condyle, and the coronoid process in the olecranon fossa. (From the Museum of St. George's Hospital.)

Symptoms.—In dislocations at the elbow joint there is great swelling and bruising of the surrounding tissues, which render the diagnosis often a matter of considerable difficulty; but in these cases of backward displacement there is always a manifest deformity about the joint. The forearm is semiflexed and generally in a position midway between supination and pronation, and is considerably shortened. The olecranon can be felt to stand out prominently behind the elbow, and above it there is a hollow in which the triceps can be felt. The lower end of the humerus can usually be defined in front, forming a round broad prominence. The head of the radius can generally be made out as a globular swelling behind the external condyle (fig. 183). The injury may be mistaken for transverse fracture of the lower end of the shaft of the humerus, but the relations between the condyles and olecranon process are altered, and the condyles do not move with the displaced olecranon; while the measurement from the acromion process to the external condyle remains unaltered.

Dislocation forwards is a very rare injury; only a few cases having been recorded where it has taken place, unless after fracture of the olecranon. It can only occur from direct violence to the olecranon when the forearm is in a position of extreme flexion. It may be complete or incomplete. In the former the olecranon is in front of the articular surface of the humerus; in the incomplete form it rests against it.

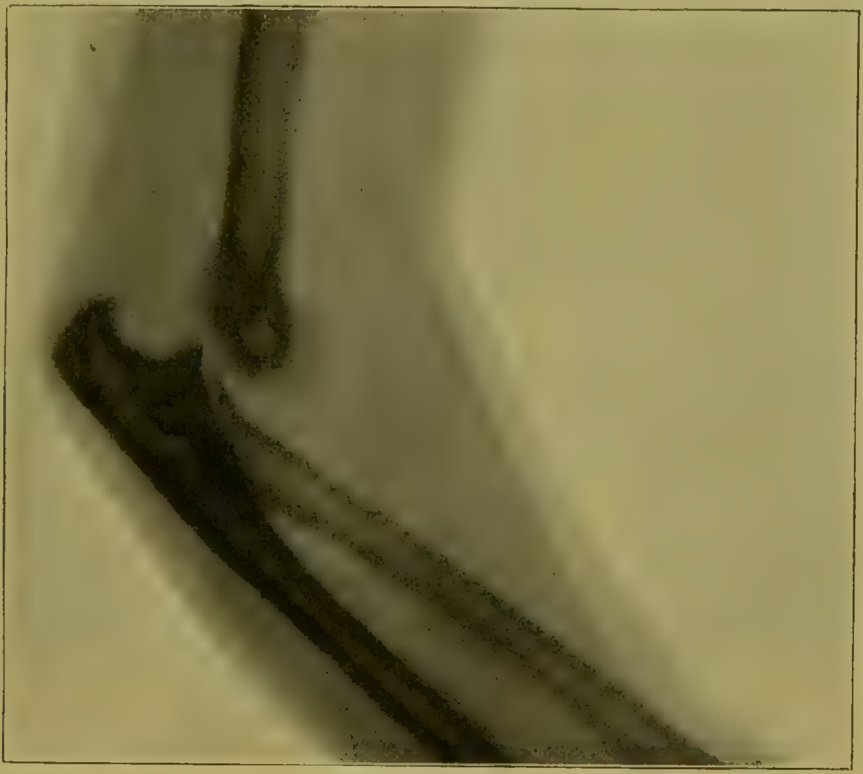


Fig. 183.—Skiagraph of a case of dislocation of the elbow backwards.

Symptoms.—The forearm is flexed and lengthened. The prominence of the olecranon is lost, and the condyles of the humerus can be felt at the back of the joint, under the triceps, which is often considerably lacerated. The head of the radius and the coronoid process of the ulna can generally be detected in front, some distance below the level of the elbow joint.

Lateral dislocation of both bones of the forearm.—These dislocations are almost always incomplete, the outward dislocation being far the more common of the two. In the *outward* dislocation the greater sigmoid cavity rests on the capitellum or radial head of the humerus, and the radius projects beyond the humerus. In the dislocation *inwards* the greater sigmoid cavity rests upon the internal condyle, while the head of the radius, strongly pronated, is lodged in the coronoid fossa of the humerus.

Symptoms.—In both dislocations there is marked deformity about the joint, which has the appearance of being wider than natural. In the dislocation outwards the head of the radius can be felt projecting beyond the external condyle of the humerus, and in the dislocation inwards there is a marked and elongated projection obscuring the internal condyle, caused by the internal border of the olecranon process. In this dislocation, evidence of injury to the ulnar nerve is very likely to be present. In both dislocations the relation of the olecranon to the condyles is altered, but the orbicular ligament remaining intact the relations of the head of the radius to the olecranon are unaltered.

Dislocation of the ulna alone is described as a classical injury, and is said to occur backwards. As this must necessitate rupture of the orbicular ligament and probably also the oblique ligament and upper part of the interosseous membrane, and as moreover there is nothing to retain the head of the radius in its place, it is very doubtful whether such an injury ever occurs. At all events it must be an exceedingly rare form of injury, and probably could not be diagnosed from displacement of both bones backwards. It is a matter of very little moment, as the treatment of both injuries is the same.

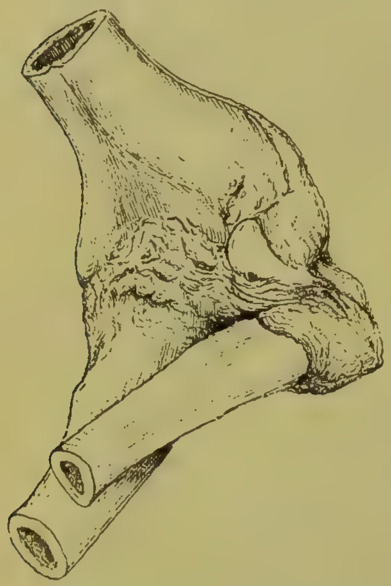


Fig. 184.—Dislocation of the radius backwards. (From the Museum of St. George's Hospital.)

Treatment.—In all the above-mentioned dislocations reduction is effected in the same way. The patient is seated on a chair, and the surgeon, with his foot on the chair, places his knee in the bend of the elbow and presses against the lower end of the humerus, at the same time grasping and fixing the bones of the forearm a little above the wrist. After this pressure has been maintained for some short time, he slowly and forcibly flexes the forearm on the arm. By this means he disengages the interlocking bony prominences and effects reduction. It rarely happens that reduction can be effected after a longer period than five or six weeks; and if the dislocation cannot be reduced, excision of the joint will probably give the patient a more useful arm, since if the dislocation is allowed to remain unreduced, great impairment of the joint and disability of movement are likely to ensue, whereas an excision, carefully planned and executed, is generally followed by most satisfactory results.

Dislocation of the head of the radius.—The head of the radius may be dislocated from the humerus and ulna, either forwards, backwards, or outwards, in cases where the orbicular ligament is torn. The accidents all appear to originate very much in the same way, by falls on the hand when the forearm is flexed, and the nature of the displacement appears to depend upon the direction in which the force is applied.

Dislocation forwards.—This is probably the most common form of displacement. The head of the bone rests on the front of the humerus, just above the capitellum. The forearm is flexed and fixed midway between supination and pronation, and the patient is unable to flex his forearm, though he can extend it. When this is done there will be seen to be a marked fulness in front of the lower end of the humerus, and the head of the radius can usually be defined in this position. On the back of the joint there is a hollow in the situation where the head of the radius ought to be.

Dislocation backwards.—Here the head of the bone rests on the back of the external condyle (fig. 184). The forearm is slightly flexed and maintained in a position of pronation. The head of the bone can be readily felt in its new position, just external to the olecranon.

Dislocation outwards is a very rare form of injury. The head of the bone is displaced outwards and upwards outside the external condyle of the humerus. It can be easily detected in this situation under the skin, forming a rounded prominence which rotates on supinating and pronating the forearm.

Treatment.—These various dislocations of the radius may be reduced in the same way. Counter extension is made by an assistant firmly grasping the lower third of the arm. The surgeon seizes the patient's hand and makes steady extension for a minute or two, and then, with his thumb on the head of the displaced bone, he suddenly flexes the forearm, at the same time pushing the head of the bone back into its place.

Sub-luxation of the head of the radius.—It is necessary to allude in this place to a peculiar injury to the elbow joint which sometimes occurs in young children, and is popularly known under the name of *pulled elbow.* It appears almost always to originate in the same way, viz. by lifting a child from the ground by the hand or forearm. The forearm becomes fixed in a position of semiflexion and midway between supination and pronation, and the child cries out with pain if any attempt is made to alter this position. The condition has been described by J. Hutchinson, jun., and others, who believe that the head of the radius has been displaced downwards in the orbicular ligament, the upper border of which becomes folded over the head, between it and the capitellum of the humerus. The condition may be rectified by placing the child under an anæsthetic and forcibly flexing and extending the limb two or three times.

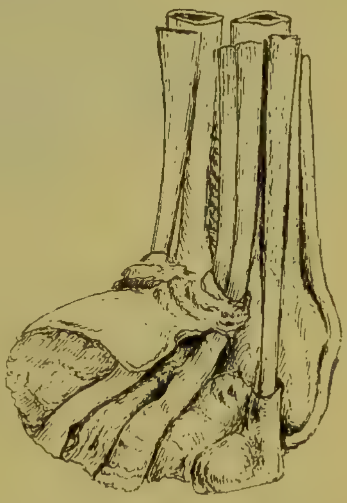


Fig. 185.—Dislocation of the carpus backwards, with fracture. The scaphoid is broken transversely; its upper half, together with the semilunar, remains in connection with the radius. (From the Museum of St. George's Hospital.)

Dislocation of the wrist is an accident of very rare occurrence. The carpus may be displaced forwards or backwards, the latter being the more common of the two (fig. 185). The deformity produced somewhat resembles Colles's fracture, but the position of the styloid processes and their relation to each other at once establishes the diagnosis (see page 439). These dislocations can usually easily be reduced by extension.

Dislocation of the radius from the ulna may occur at the inferior radio-ulnar joint from violent twists. The radius may be displaced either backwards or forwards. The lesion can be easily recognised by the deformity, and there is generally no difficulty in effecting reduction.

The **carpal bones** are sometimes displaced from each other by great violence. These injuries are generally the result of machinery accidents, and are often compound, and are to be treated on general principles. The only one which requires special mention as a definite lesion is dislocation of the head of the os magnum backwards from the scaphoid and semilunar bones. This occurs from great violence to the hand when the wrist is flexed. The head of the bone can be easily recognised as a globular prominence on the back of the wrist, especially prominent during flexion, and disappearing somewhat during extension. It can usually be reduced by extension and making direct pressure over the head of the bone.

Dislocation of the metacarpal bones and phalanges.—The only one of these which requires separate mention is dislocation of the first phalanx of the thumb. This may be dislocated from the head of the metacarpal bone, either backwards or forwards, the former being the much more common dislocation of the two. It is usually caused by falls on the hand with the fingers and thumb outstretched, the phalanx being driven backwards and its base becoming lodged behind the head of the metacarpal bone. The dislocation produces the most characteristic deformity. The proximal phalanx is bent backwards almost to a right angle with the metacarpal bone, and at the same time the terminal phalanx is flexed. The head of the metacarpal bone can be felt in front. This dislocation owes much of its interest to the difficulty which is often experienced in effecting reduction, owing to the fact that the head of the metacarpal bone becomes driven forwards between the two bellies of the flexor brevis pollicis, which tightly grip the neck and so 'buttonhole' the head of the bone and prevent its reduction; for traction on the thumb tenses the two bellies of the muscle, and so tightens the gap between them and prevents the head of the bone escaping (fig. 186).

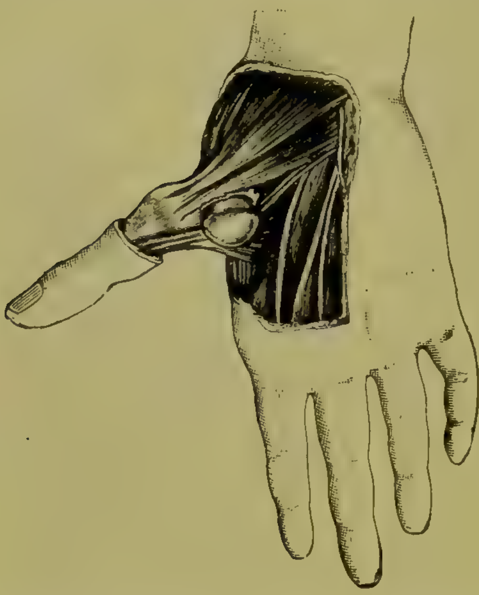


FIG. 186.—Dislocation of the metacarpo-phalangeal joint of the thumb. The head of the metacarpal bone has been forced forwards between the two heads of the flexor brevis pollicis. (From Pick's 'Fractures and Dislocations.')

Treatment.—Reduction is to be effected by forcibly adducting the metacarpal bone to the palm, so as to relax as much as possible the flexor brevis pollicis, and then making extension with the thumb hyper-extended, and finally suddenly flexing the phalanx on the metacarpal bone, whilst extension is still kept up. If this does not succeed it is better to expose the parts and hook on one side or divide any resisting structures. Of course this must be done with careful antiseptic precautions.

DISLOCATIONS OF THE LOWER EXTREMITY

Dislocation of the hip.—The hip is not nearly so frequently dislocated as the other great ball-and-socket joint—the shoulder. It enjoys this immunity partly on account of the shape of the articular surfaces—a large segment of a small sphere articulating with a deep cup-shaped cavity—and partly to the strength of the ligaments and muscles by which it is surrounded. The accident usually occurs during adult life, between the ages of twenty and forty-five: rarely in children, and still more rarely in advanced life, any injury to the hip in this later period of life being attended with fracture rather than dislocation.

The head of the femur may be displaced to 'any point around its socket' (Bryant). But it is customary, for purposes of description, to classify dislocations of the hip as occurring in four different directions: (1) upwards and backwards, on to the dorsum of the ilium; (2) backwards into the neighbourhood of the sciatic notch; (3) forwards and downwards, into the obturator foramen; and (4) forwards and inwards, on to the os pubis.

As regards the relative frequency with which these varieties of dislocation are met with, a general idea may be obtained from 292 cases collected from various sources. Of these, 53·1 per cent. were dislocations on to the dorsum of the ilium; 24·3 per cent. were sciatic; 14 into the obturator foramen; and 8·6 per cent. on to the os pubis.

Mechanism of dislocations of the hip.—The manner in which a dislocation of the hip is brought about is still involved in some doubt. Most surgeons, however, believe that in the great majority of cases the primary dislocation is downwards, and that the position the head of the bone subsequently assumes—whether on to the dorsum of the ilium, into the sciatic notch, or on to the os pubis—is dependent upon the position of the limb with respect to rotation and flexion, or to the direction of the violence. It is believed that in these cases the limb is in a position of abduction at the moment of the accident. When the femur is abducted, owing to the shallowness of the lower and inner part of the cotyloid cavity the head of the femur bulges over its margin and presses upon the capsular ligament at its lower and inner part. And when it does this it presses upon the weakest part of the capsular ligament: the capsule is thick and strong behind and above, and especially in front, where it is strengthened by the ilio-femoral ligament, whilst below and internally it is comparatively thin and weak. Hence it follows that when any violence is applied while the thigh is abducted and the head of the bone is pressing on this weak part of the ligament, a rupture of it may occur, and the head of the bone be displaced primarily downwards.

Mr. Henry Morris strongly maintains the opinion that the subsequent position which the head of the bone assumes is determined by the degree of flexion or extension, and of inward and outward rotation of the femur at the moment of luxation. He says that if the femur is flexed and rotated inwards, as well as abducted, at the moment of the accident, the head of the bone will be forced backwards, and either dislocation on to the dorsum or into the sciatic notch result; the sciatic dislocation requiring a greater degree of flexion and inward rotation than is required to produce the dislocation on to the dorsum ilii. But if the thigh is extended and rotated outwards, with abduction, the head of the bone will find its way on to the os pubis; but if there is no rotation at all, merely abduction with extension, the head of the bone remains in or near its initial position, i.e. in the obturator foramen.

Though it is very probable that this explanation of the mechanism of dislocation of the hip is true in the greater number of cases, there is undoubted evidence to prove that the head of the femur may be dislocated in cases where there is no abduction, and where on the other hand the limb is adducted. In these cases there is a primary dorsal dislocation, the head of the bone escaping through a rent in the capsule behind and above the tendon of the obturator internus. These cases are sometimes, but not always, accompanied by a fracture of the posterior margin of the acetabulum.

Dislocation on to the dorsum ilii.—This is the most common form of dislocation of the hip. The head of the bone rests on the dorsum of the ilium at a varying distance above the acetabulum. It is always situated above the obturator internus; while the sciatic dislocation is situated below this muscle. This fact induced Bigelow to give the names of 'dislocation above and below the obturator internus muscle' to these two injuries respectively. The ligamentum teres and the capsule are necessarily torn. The rent in the capsule may be either below in those cases in which the dislocation is produced in the usual way, but may be behind when the displacement is direct; or, instead of the capsule being torn, the back part of the rim of the acetabulum may be broken off. The ilio-femoral ligament as a rule is not torn; and when this is so, it forms an important adjunct to the reduction by manipulation. The muscles around the joint, and especially the external rotators, are frequently lacerated.

Symptoms.—There is marked deformity about the hip, which seems to be widened out and flattened. The trochanter is raised above its natural position and approximated to the anterior superior spine. The head of the bone can usually be made out in its new position. The limb is shortened, generally to the extent of two or three inches. The thigh is flexed, adducted, and rotated inwards, so that the direction of the axis of the femur is across the lower third of the sound thigh, and the ball of the great toe rests on the sound ankle, the knee being somewhat flexed. The vessels in the groin can be felt to have lost their support, so that they can be pressed backwards into a hollow behind. The only injury with which this dislocation is liable to be mistaken is an impacted fracture with inversion; but the displaced head of the bone on the dorsum of the ilium can almost always be made out on careful examination.

Treatment.—The way in which the surgeon should endeavour to reduce this dislocation is by manipulation, and if the patient is seen shortly after the accident, he will generally succeed if he rigidly follows the directions, which were first formulated by Bigelow. The patient should be placed on a mattress on the floor and anæsthetised, so that the muscles are completely relaxed. The surgeon then grasps the limb and flexes the leg on the thigh, and the thigh on the pelvis, until he can flex it no further; in doing this the thigh should also be somewhat adducted, so that the knee is beyond the median line. The limb is to be maintained in this position for some moments, and then, the flexion still being kept up, the thigh is to be abducted to its widest extent; and this having been done, it is next to be rotated outwards as far as possible and brought suddenly down into the extended position. By this series of manœuvres the head of the bone will be made to retrace the steps by which it has been dislocated, and the head of the bone will be returned into its socket. That this is so, will be known by a peculiar sound being heard and all deformity being removed. These various movements may be remembered shortly thus: Bend up; roll out; turn out; and extend.

The explanation of this process is as follows. By flexing the leg on the thigh the hamstring muscles and the great sciatic nerve are relaxed; by flexing the thigh on the pelvis, the front of the capsule and the ilio-femoral ligament are relaxed, and the head of the bone is forced from above and behind the acetabulum to below and behind it; by abducting the thigh the head is forced from below and behind the acetabulum to below and in front, to the position of the rent in the capsule. This is mainly effected through the agency of the ilio-femoral ligament, which acts as the fulcrum of a lever of the first kind, and, as the knee is rolled outwards, fixes the neck and causes the head of the bone to glide inwards. Finally, by rotating the femur outwards, the head of the bone is raised upwards and outwards and caused to enter the rent in the capsule, and by extension is carried to the bottom of the acetabulum.

In case this plan of reducing the dislocation by manipulation does not succeed, recourse must be had to extension. The simplest and best plan is the one advocated by Kelly. It consists in placing the patient on his back on the floor. His pelvis is fixed by strong webbing passed across it and fastened to screw hooks inserted in the floor. The injured thigh is flexed to a right angle with the trunk, and the surgeon, standing over the patient and bending forwards, passes his forearms behind the patient's knee and grasps his own elbows. The dorsum of the patient's foot rests against the perineum of the surgeon. He is now in the best position to accomplish the reduction by drawing the limb directly upwards. This will generally succeed in reducing the dislocation. Should it not do so, circumduction may be added: whilst still maintaining traction, the surgeon bends his body to the injured side, then forwards towards the patient's head, then outwards away from the injured side, and finally, by stepping backwards, he brings the limb downwards into a condition of extension, and in all probability the head will slip into the acetabulum.

Formerly attempts were made to reduce dislocations of the hip by means of multiplying pulleys, but in recent dislocations one or other of the methods described above will generally be found sufficient, and the use of the pulleys is not to be advocated; and in old dislocations the probabilities of effecting any good by the pulleys are so slight, and the probabilities of doing serious damage so great, that it would seem better to leave the dislocation unreduced, in the hopes that after a time a new socket may be formed and a fairly useful limb be obtained; or to expose the head of the bone, divide all resisting structures, and replace or excise the head of the femur.

Dislocation backwards into the neighbourhood of the sciatic notch.—This dislocation is usually termed *dislocation into the sciatic notch*, but there is no evidence to prove that the head of the bone is actually driven into the notch, and some surgeons doubt whether it ever is so; and it would appear that in most cases the head of the bone rests on the posterior surface of the ischium, between the edge of the acetabulum and the margin of the great sacro-sciatic notch, below the tendon of the obturator internus.

Symptoms.—The signs of this dislocation are very similar to those of the previous one, but less marked. There is flattening about the hip, and the trochanter is displaced, though not to the same extent as in the dislocation on to the dorsum. The limb is shortened to the extent of about an inch. The thigh is adducted and rotated inwards, so that the ball of the great toe rests on the great toe of the opposite foot. The direction of the axis of the femur is across the knee of the sound side, instead of across the lower third of the thigh as in the dorsal dislocation, and it is by this sign that the one form of displacement is distinguished from the other. The head of the bone is often felt with difficulty, or perhaps, buried beneath the glutei muscles, it cannot be felt at all.

The **treatment** of this dislocation is to be carried out in the same manner as in the dislocation on to the dorsum ilii.

Dislocation into the obturator foramen.—In this dislocation the head of the bone usually rests on the obturator externus muscle, close to the inner margin of the obturator foramen ; but sometimes it is displaced further inwards, and rests on the rami of the os pubis and ischium.

Symptoms.—There is an appearance of deformity about the hip, which is flattened. On the outer side there is a depression where the trochanter ought to be ; in front there is a hollow below the middle of Poupart's ligament ; internally there is a tense cord, which stands out prominently beneath the skin, caused by the tense adductor longus muscle ; behind, the fold of the buttock is on a lower level than natural. There is lengthening of the limb : this, however, is more apparent than real, and is in a great measure due to tilting downwards of the pelvis on the affected side ; but there may be a little real lengthening. If the patient assumes the erect position, this obliquity of the pelvis will be very perceptible, and the body will also be bent forwards, owing to the tension of the ilio-psoas muscle. The limb will be seen to be abducted and advanced in front of the other, with the toes either slightly everted or pointing straight forwards. The head of the bone, if it rests on the obturator externus muscle, is not very easily felt ; but if it is advanced further inwards, it can be readily felt and even seen as a globular mass under the tense skin of the perineum. Patients in whom this dislocation has been allowed to remain unreduced are often able to walk without pain or difficulty.

Treatment.—There is not generally much difficulty in reducing an obturator dislocation by manipulation, as the bone has not travelled far from the place where it left the capsule, and therefore all that is necessary is to make it re-enter the rent in this structure. The patient having been placed on a mattress on the floor, and anæsthetised, the surgeon standing over him grasps the knee with one hand and the ankle with the other, and flexes the leg on the thigh and the thigh on the pelvis, at the same time slightly abducting it, and by this means disengages the head of the bone from the structures on which it rests, and brings it close to the rent in the capsule. By now rotating the femur strongly inwards he causes the head of the bone to enter the rent in the capsule, and then adducting it and carrying the knee to the floor by a movement of extension he completes the reduction.

Dislocation on to the os pubis.—In this dislocation the head of the bone rests on the os pubis, generally close to the anterior inferior spinous process of the ilium, but sometimes more internally, nearer the pubic spine.

Symptoms.—The most marked sign of this dislocation, and a very characteristic one, is the presence of the head of the bone in its new situation. It can be distinctly felt, as a round hard ball, in the groin, rather above the level of Poupart's ligament. There is an absence of the prominence of the great trochanter, and a depression in the position where it ought to be. There is generally about an inch of shortening, and the thigh is markedly everted and more or less abducted from the middle line of the body. Frequently intense pain is complained of in the lower extremity, from pressure of the head of the bone on the anterior crural nerve.

Treatment.—The pubic dislocation can generally be reduced by manipulation—that is to say, by making the head of the bone retrace the steps by which the dislocation was brought about. The patient is to be placed on his back on the floor and under the influence of an anæsthetic. The leg is to be flexed on the thigh and the thigh on the pelvis, with a certain amount of abduction, so that the knee is beyond the line of the side of the body. The limb is to be held in this position for a few moments, and then slowly carried inwards into a condition of adduction, so that the knee is over the middle line of the body. By this means the head of the bone is forced round the inner side of the cotyloid cavity to the rent in the capsule through which it emerged. Care must be taken not to adduct the limb too far, or else the head of the bone will slip past the socket and a dislocation backwards result. After this motion has been accomplished, the limb is to be rotated outwards, when the head of the bone will enter the rent in the capsule ; and by extending the limb the head will be carried to the bottom of the cavity, and the dislocation will be reduced. Rotation inwards seems to succeed in some cases equally well as rotation outwards.

In cases where manipulation fails to reduce the dislocation, the plan advocated by Mr. Kelly for dislocations backwards (page 515) sometimes succeeds in reducing the dislocation. Other plans, by combining extension with manipulation, have occasionally been adopted with success. Thus, after flexing the thigh, the head of the bone may be dragged directly outwards, by means of a long towel placed around the upper part of the thigh. In order to accomplish this most satisfactorily, the patient should be laid on his sound thigh, and the towel can then be placed over the shoulders of the surgeon, who, standing over his patient, fixes the pelvis by placing his foot upon it. An assistant grasps the ankle and steadies the lower part of the limb.

After the reduction of any of these forms of dislocation of the hip, the subsequent treatment must be carried out on the lines laid down above (page 498). In the intervals between the daily massage, it is not as a rule necessary to apply any splint, but merely to support the limb on either side with a sandbag, a long one reaching to the pelvis on the outer side, and a short one reaching to just above the knee on the inner. A couple of turns of bandage round the bags, inclosing the knee, will be all that is required to secure the necessary quietude.

Occasionally it will happen that the dislocation will recur after reduction. This will probably be due to the injury being complicated with fracture of the rim of the acetabulum, and during reduction crepitus will probably have been felt. These are exceedingly difficult cases to deal with, for, in spite of all the extension which can be made, the head of the bone is very likely to become permanently displaced, and deformity and lameness result. In cases where fracture is suspected, after reduction of the deformity, the limb should be put up with weight extension, and an outside long splint applied.

Dislocations of the patella.—The patella may be dislocated outwards, inwards, and edgewise—that is, vertically rotated. In addition to these, a dislocation upwards is occasionally described. This is, however, really a rupture of the ligamentum patellæ, and a consequent dragging upwards of the patella from muscular action, and can scarcely be regarded as a dislocation.

Dislocation outwards.—This is by far the most common dislocation, and its greater frequency is due to the oblique direction of the femur, so that the quadriceps extensor does not act in quite a straight line, but drags the patella outwards. This is compensated for, in a measure, by the greater prominence of the external condyle, which counteracts this tendency; but any sudden or violent contraction of the muscles may overcome this obstacle and produce a dislocation. It will be readily understood, therefore that in cases of knock-knee, where the angle which the tibia forms with the thigh bone is increased, this tendency to dislocation of the patella outwards from muscular action is very much greater. In addition to dislocations from muscular action, which is the most common cause, the patella may also be displaced outwards by direct violence. A blow on the inner border of the patella, which is more prominent than the outer border, may force the bone outwards over the external condyle and produce a dislocation. The dislocation always takes place when the leg is extended, since during flexion the bone is lodged in the intercondyloid notch. It may be complete or incomplete. In the complete form the bone is thrown entirely off the articular surface of the femur, and undergoes a partial rotation on a longitudinal axis through its own centre; and the cartilage-clad surface of the bone is directed inwards in contact with the outer surface of the external condyle, while the internal border is directed forwards. In the partial or incomplete dislocation the internal articular facet of the patella rests against the cartilaginous surface of the external condyle and its inner border in the intercondyloid notch. In these cases there is also a partial rotation of the patella, but in the opposite direction, the outer border being the most anterior. Partial dislocation, and probably also complete dislocation, may occur without any laceration of the capsule, and it therefore seems probable that an important predisposing factor in the causation of these dislocations is relaxation of the ligaments.

Symptoms.—The signs of this dislocation are sufficiently obvious. The knee is flattened and broader than natural, and a depression is felt in the position the patella normally occupies, in which, on deep pressure, the intercondyloid notch can be felt. In the complete dislocation the bone can be felt on the outer side of the joint, and in the incomplete form the external border can be seen and felt projecting prominently under the skin.

Dislocation inwards.—The dislocation inwards is exceedingly rare and is always the result of direct violence, that is to say, from blows on the outer border of the bone; and as this border is protected by the prominent external condyle, blows in this situation, sufficiently severe to cause dislocation, are infinitely rare. Like the former dislocation it may be complete or incomplete, and the symptoms are much the same, except that the position of the bone as regards its displacement and its rotation is reversed.

Treatment.—The patient having been placed under an anæsthetic, the leg is extended on the thigh and the whole limb flexed as much as possible at the hip, and then direct pressure is made on the prominent margin of the bone, and it is pushed back into its place. Sometimes in the partial form it is difficult to dislodge the inner border from the intercondyloid notch; under these circumstances the outer border should be forcibly depressed: this raises the inner border, frees the bone, and the muscles by their action draw it into its natural position.

Dislocation edgewise, or vertical rotation, of the patella.—In this peculiar injury the patella undergoes a vertical rotation around a longitudinal axis through its own centre. In consequence of this one border, in rather the greater number of cases the internal, is lodged in the intercondyloid notch, and the other projects forwards under the skin; the two surfaces looking inwards and outwards. In a more complete form of the same displacement the patella undergoes a greater rotation, and the articular surface is directed forwards, the subcutaneous anterior surface resting in the intercondyloid notch. The most common way in which this displacement is produced is by sharp blows on one or other edge of the patella; but it has been said also to occur from violent muscular contraction whilst the leg is twisted, as in jumping with the foot inverted or everted.

Symptoms.—The signs of this dislocation are very evident; the sharp prominent border can be felt as a hard well-marked edge under the skin, with a depression on either side of it. The limb is extended and cannot be flexed.

Treatment.—As a rule, reduction may be accomplished by forcibly and suddenly bending the knee whilst the patient is under an anæsthetic, or by forcible pressure on the prominent margin of the bone while the limb is flexed at the hip. Some cases, however, resist all efforts at reduction. This is probably due to the bone becoming entangled in the torn capsule. In these cases the treatment must either consist in exposing the bone with strict antiseptic precautions, and, after freeing it, replacing it in its natural position; or in leaving the dislocation unreduced. In cases where this latter alternative has been adopted, a fairly useful limb has been the result. After reduction there will probably be some considerable swelling and effusion in the joint, and early massage and passive motion must be employed. The patient should be enjoined to wear a knee-cap for some considerable period of time, as a recurrence of the dislocation is very apt to take place.

Dislocation of the knee.—The tibia is very rarely dislocated from the femur, on account of the great strength of the ligaments which bind the bones together, and the breadth of the articular surfaces. When it is, it is always the result of extreme violence, such as machinery accidents, when the dislocation is often compound; falls from a great height; jumping from a carriage in rapid motion. The dislocation may occur in four principal directions: forwards, backwards, inwards, or outwards. The antero-posterior dislocations may be complete or incomplete; the lateral ones are always incomplete. The dislocation **forwards** is usually complete, and is of more frequent occurrence than the dislocation backwards. The upper end of the tibia is displaced forwards and is drawn considerably upwards, so that the posterior surface of the upper end of the tibia lies in front of the lower end of the femur. The lower end of the femur projecting into the ham may press upon the popliteal vessels and arrest the circulation through them. In many instances of this form of dislocation there is lateral displacement as well.

The dislocation **backwards** (fig. 187) may be complete or incomplete. In the complete form the displacement of the bones is not so great as in the forward dislocation, and injury to or compression of the vessels in the ham does not so frequently occur. The anterior border of the tuberosities of the tibia rests against the posterior surface of the condyles, and the shortening is not so much as in the other variety.

The **lateral displacements** are much more common than the antero-posterior. They are always incomplete, and are generally accompanied by a certain degree of rotation. In these dislocations the articular surface of the outer tuberosity rests on the internal condyle, or the articular surface of the inner tuberosity rests on the external condyle, according as the displacement is inwards or outwards.

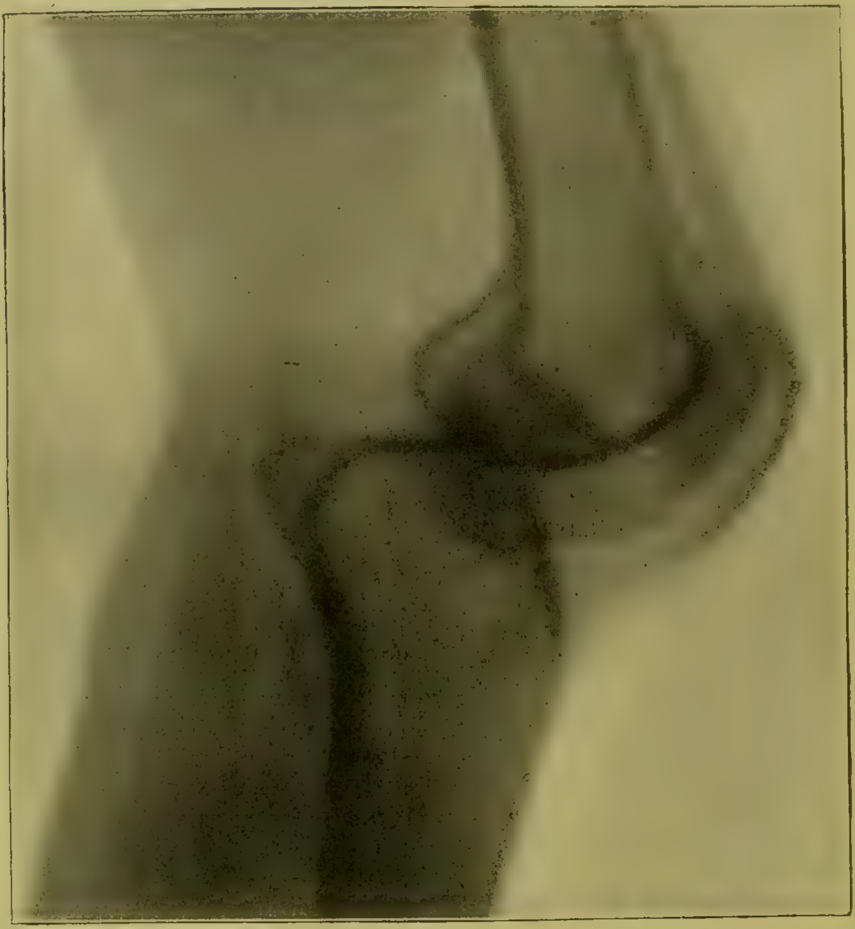


FIG. 187.—Skiagraph showing dislocation of the knee.

Symptoms.—There is no difficulty in diagnosing these accidents, as the nature of the case is apparent at a glance, and the displaced bone can usually be easily felt in its new position. There is generally a very considerable amount of swelling and bruising about the knee. In the antero-posterior displacements attention must be paid to the circulation below, to ascertain whether the vessels have been injured or compressed.

Treatment.—In order to reduce these dislocations, the thigh should be flexed on the pelvis, and extension made. Whilst this is being maintained, the surgeon must endeavour by manipulation and pressure to push the bones back into their normal position. In consequence of the fact that the knee joint owes its integrity mainly to its ligaments, and these have been ruptured, passive motion must not be commenced too early, probably not till the end of the second week, and must even then be conducted with the greatest care and gentleness. Massage may, however, be applied with advantage from the first. It is desirable for the patient for some considerable time to wear a knee-cap, as a recurrence of the dislocation is likely to occur unless some artificial means of support is employed.

Displacement of a semilunar cartilage.—This by no means uncommon accident was first described by Hey under the name of *internal derangement of the knee joint.* It consists in displacement of the whole or a part of one of the semilunar fibro-cartilages, the ligaments by which it is held in position being torn by violence, or the cartilage itself split. Sometimes a portion of one of the cartilages may be separated from all its connections and remain as a loose body in the joint. The varieties of the displacement are several : the cartilage may be separated from the head of the tibia by tearing of the coronary ligament, and may then be displaced either outwards or inwards ; or the cartilage may be torn away from its anterior attachment, and be folded backwards into the intercondyloid notch. As a matter of clinical experience, the internal cartilage is much more frequently displaced than the external, though Godlee has brought forward several good anatomical reasons for supposing that the external one would be the more likely to be displaced.

Causes.—The cause of this accident is some sudden wrench or twist in the leg whilst it is in a position of flexion. Thus it may occur in swinging the body in making a stroke at golf, or in turning quickly in games of tennis or cricket, or in twisting the body from slipping off the kerb. It would appear that the position of flexion or semiflexion is necessary for the occurrence of this injury. During extension the cartilages are flattened out and squeezed between the two bones, and are immovably fixed ; but during flexion the ligaments are somewhat relaxed, and therefore the cartilages are to a certain extent movable on the upper surface of the tibia. Again, during extension of the knee, no rotation of the tibia is possible, and the semilunar cartilages remain fixed on the tibia ; but when the knee is flexed a certain amount of rotation is possible.

Symptoms.—The signs of this injury are a sudden severe and sickening pain in the knee, following some strain or muscular effort. The limb immediately becomes fixed in a position of flexion or semi-flexion, and the patient is unable to extend it. A certain amount of passive motion may be possible, but the patient is unable to voluntarily move his joint. If the cartilage has been displaced outwards, a smooth rounded projection will be felt on the inner or outer side of the joint, according as to whether the internal or external cartilage has been displaced. But if the cartilage has been dislocated inwards, no projection will be felt ; but there may be a depression between the condyle of the femur and the upper end of the tibia, in the position from which the cartilage has been displaced. The injury is speedily followed by an attack of sub-acute synovitis, with effusion into the joint.

Treatment.—The plan of treatment recommended by Hey is usually successful in restoring the cartilage to its natural position. It is generally desirable to administer an anæsthetic, and then flex the leg on the thigh to its fullest extent; this relaxes the pressure of the condyles of the femur on the cartilage and renders it more movable. By now suddenly extending the leg the displaced cartilage will generally slip into its place. The patient, if he is not under the influence of an anæsthetic, will at once be conscious that the displacement is reduced, and will again be able to move his leg. In some instances it has been found impossible to restore the cartilage to its proper position; when this is so, passive motion should be persevered with for some time, beginning it as soon as the symptoms of synovitis have subsided, and generally a very useful limb will be obtained.

As soon as reduction is accomplished the limb should be placed on a splint, and cold lotion or ice applied, to reduce the inflammation. Passive motion should be begun early. It must be borne in mind that this accident is very liable to recur unless means are taken to ensure the union of the ruptured ligamentous tissue. This is best done by applying to the knee a clamp which has been especially devised for these cases. This consists of a semicircular spring, which passes behind the joint, and is attached on either side to a carefully padded plate, which is shaped to embrace the lateral borders of the patella and make pressure upon them. This should be applied as soon as it is judged advisable to allow the patient to have his limb removed from the splint, which certainly should not be for three weeks after the accident.

In cases where, in spite of treatment, or for want of proper treatment, a recurrence occurs, a repetition may often be prevented by wearing the same clamp; but where the accident has occurred more than once, it will often be found that the cartilage is constantly slipping in and out, and seriously interferes with the patient's comfort and welfare. Should this be so, or should the cartilage be irreducible and seriously cripple the patient, operative interference will have to be undertaken. This must be done with the strictest antiseptic precautions, and no surgeon is justified in undertaking it unless under these conditions.

The operation is performed by making an incision (with the knee flexed to a right angle) a finger's breadth from the patella, commencing it opposite the middle of this bone and carrying it to an inch below the head of the tibia. The skin, subcutaneous structures, and the capsule are divided, and the synovial membrane exposed. This is opened nearly to the same length as the skin incision. The position of and extent of injury to the cartilage is now ascertained by introducing the finger into the joint. If the cartilage is curled up into the intercondyloid notch, or if it is considerably lacerated, it had better be removed; but if its anterior attachment or the coronary ligament has simply been torn, it may be sutured down to the head of the tibia. In order to remove the cartilage, it should be seized with a pair of catch forceps and pulled outwards as far as possible, and a pair of scissors being introduced into the joint on the under surface of the cartilage, it is cut away as near its posterior attachment as possible. When the cartilage is to be sutured, a curved needle mounted on a handle is passed through the fibrous tissue about the head of the tibia, and then through the cartilage near its circumference. A piece of chromic catgut is then threaded through the needle, and it is withdrawn and the suture tied. In this way, one, two, or three sutures may be inserted. The wound is now to be closed, a drainage tube having been first inserted. In suturing the wound, great care must be taken to pick up both edges of the synovial membrane in each stitch, so that when they are tied the two cut edges of the membrane shall be brought into contact. Before the sutures are tied, the joint should be thoroughly irrigated with hot sterilised water, so as to wash away all blood clot. The drainage tube should be removed at the end of forty-eight hours. Care must be taken, by means of splints, to absolutely immobilise the limb after the operation.

Dislocation of the head of the fibula.—This very rare accident may take place from direct blows on the upper part of the bone, and the head may be displaced either backwards or forwards. It can always be felt in its new position, and can usually be easily reduced by flexing the leg so as to relax the biceps, and by making pressure upon it. But it is exceedingly difficult to retain the bone in position, and the patient usually recovers with some permanent deformity. This does not, however, appear to interfere much with his powers of progression.

Dislocation of the ankle.—The ankle joint is a very powerful and strong articulation, and great force is required to produce dislocation. Nevertheless, on account of its exposure to injury, dislocation does frequently occur.

The tarsus may be displaced from the tibia and fibula either in a lateral or in an antero-posterior direction. The lateral dislocations are much the more common, and on account of the manner in which the astragalus is wedged like a tenon into the mortise of the tibia and fibula, these dislocations are almost of a necessity accompanied by fracture. They are incomplete, and are not true lateral displacements; but the astragalus becomes partially displaced from the articular surfaces of the tibia and fibula, undergoing a rotation on its own horizontal axis, so that the outer or inner margin of its superior surface, according to the variety of the displacement, rests against the articular surface of the tibia. When the displacement is outwards the fibula is broken about three inches from its lower extremity; the internal lateral ligament is torn or the internal malleolus into which it is inserted broken off, and what has already been described as Pott's fracture is produced. If the violence applied has been greater, the interosseous tibio-fibular ligament is also torn, and the astragalus is displaced upwards as well as outwards, constituting Dupuytren's fracture. When the dislocation is inwards, which is not nearly so common as the outward dislocation, the lower end of the tibia is broken obliquely from within outwards, and the external lateral ligament torn or the external malleolus fractured. These injuries have already been described in the chapter on Injuries and Diseases of Bones (see page 458).

Antero-posterior dislocation of the ankle.—The antero-posterior dislocations of the ankle are not nearly so common as the lateral dislocations. The tarsus may be displaced either backwards or forwards, the former dislocation being the more common of the two. These dislocations are produced by violence applied to the leg while the foot is fixed, and are most frequently caused by jumping from a carriage in motion, or falls from a height on to the feet: there is thus a sudden arrest or fixation of the foot while the leg is carried onwards. The dislocation backwards is almost always accompanied by fracture, though cases have been reported where no fracture has taken place. The dislocation forwards more frequently occurs without fracture. Either dislocation may be complete or incomplete.

Dislocation backwards.—In the complete form of this dislocation the lower end of the tibia rests on the neck of the astragalus and the navicular, and the articular surface of the astragalus is completely behind the tibia; in the incomplete form the two articular surfaces are not quite clear of each other.

Symptoms.—There is marked deformity and shortening of the foot. In front of the ankle the tibia can be felt as a prominent transverse ridge of bone, terminating below in an abrupt margin. The os calcis projects posteriorly, and the tendo Achillis is prominent and stands out tensely under the skin. The toes are pointed downwards.

Dislocation forwards.—This dislocation is very rarely complete; when it is, the articular surface of the lower end of the tibia rests on the posterior part of the upper surface of the os calcis, just in front of the tendo Achillis. In the incomplete form, it rests partially on the articular surface of the astragalus.

Symptoms.—In these cases the foot is elongated; the heel is less prominent than natural, and the tendo Achillis is lax. Immediately in front of it can be felt the lower end of the tibia.

Treatment.—These dislocations are to be reduced by traction. The patient is laid on his back, with the leg flexed on the thigh, to relax the tendo Achillis, and held in this position by an assistant. The surgeon then makes steady and firm extension from the foot, at the same time gently moving it from side to side with a rocking movement, so as to disengage the astragalus. The dislocation backwards is much easier to reduce than the dislocation forwards. Should any difficulty occur, it may usually be overcome by dividing the tendo Achillis.

Dislocation upwards is an accident of extreme rarity, but well-authenticated cases have been recorded. It consists in the articular surface of the astragalus being forced upwards between the tibia and fibula, the interosseous ligament between the two bones having first been torn. It appears to be always caused in the same way, by falls from a height on to the feet.

Symptoms.—There is great widening of the ankle, and the two malleoli stand out prominently under the skin, and are nearer the level of the sole of the foot than natural. Movement at the ankle joint is lost.

Treatment.—The displacement is to be overcome by traction in the same manner as in the foregoing dislocation. Cases have been recorded in which it has been found impossible to overcome the displacement, the astragalus being so tightly jammed between the two bones of the leg.

Dislocation of the astragalus.—The astragalus may be dislocated from all its articulations: from the tibia and fibula above, the os calcis below, and the navicular in front; and the displacement may be either forwards, backwards, or laterally to either side. In addition to this, cases have been recorded where the astragalus has become dislocated from all its surroundings, and then undergone a rotation or version, either horizontally, so that the long axis of the bone is across the joint, or it may be turned on its side, so that its upper and under surfaces look inwards and outwards respectively.

Dislocation forwards is the most common lesion. The astragalus is shot out from its socket, and in the complete form is detached from all its connections and rests on the navicular and cuneiform bones. It is generally compound, the head of the bone protruding from the wound. In the incomplete form the under surface of the neck rests on the posterior superior border of the navicular. In both forms the astragalus usually undergoes a partial rotation, so that the head is directed forwards and outwards, or forwards and inwards, the former being the more common. The injury is generally the result of severe violence applied to the foot, while it is fully extended on the leg.

Symptoms.—The signs of the injury are unmistakable. The rounded globular head of the astragalus is readily recognised under the tense and stretched skin, and behind this can be felt the upper articular surface of the bone in front of the tibia.

Dislocation backwards is uncommon. It would appear to be caused by violence applied to the foot whilst in a position of extreme flexion. The dislocation is usually complete, and the astragalus rests on the posterior part of the upper surface of the os calcis. The marked sign of this dislocation is the presence of the astragalus just above the heel, between the tendo Achillis and the malleoli. The tibia is prominent in front, and the foot is shortened.

Lateral dislocations of the astragalus are almost always compound, and are usually accompanied by fracture of one or both malleoli.

Version of the astragalus.—In this peculiar accident the astragalus, separated from all its articulations, undergoes a rotation either on a horizontal or vertical axis. It is produced by violent strains or wrenches to the foot, when it is in a position of neither extreme flexion nor extension.

Symptoms.—The diagnosis of this injury is generally difficult, because it is accompanied by so much swelling that the parts of the astragalus cannot be defined. The history of the accident, the loss of motion in the ankle joint, and the evidence of severe injury without any great deformity, would lead the surgeon to suspect this injury, and the diagnosis would be established by the Röntgen rays.

Treatment.—The treatment of dislocation of the astragalus must depend upon whether the dislocation is complete or not. In the complete form, any attempt to reduce the bone will probably fail, and the best plan would appear to be to remove the bone, as these dislocations are almost always compound. This adds in no way to the danger of the accident: in fact, far otherwise, as it enables the surgeon more thoroughly to cleanse the wound and render it aseptic, and the use of the foot after removal of the bone is not materially impaired. In cases of incomplete dislocation reduction is to be attempted by traction from the foot while the leg is flexed, and by making pressure on the displaced bone. If this does not succeed, the tendo Achillis should be divided and another attempt made. Failing this, the proper treatment would be to cut down and remove the bone with antiseptic precautions.

Sub-astragaloid dislocation.—In the sub-astragaloid dislocation the astragalus remains in situ in the tibio-fibular mortise, and the other bones of the tarsus are dislocated from it. The displacement is usually described as taking place either backwards, forwards, or laterally; but the first of these is very much the more common, and is the only one which requires description. In the so-called dislocation backwards there is always a certain amount of lateral displacement as well, the foot being displaced either backwards and outwards, or backwards and inwards, from the astragalus. The injury is produced by severe twists or wrenches of the foot: a not uncommon way for it to occur is when an individual is thrown from his horse and is dragged along the ground with the foot fixed in the stirrup.

The dislocation is usually incomplete as regards the astragalo-calcanean joint, some portion of the articular surface of the astragalus remaining in contact with the articular facets on the upper surface of the os calcis; but the dislocation is complete as regards the articulation of the head of the astragalus with the navicular bone.

In the dislocation backwards and outwards—the more common variety—the head of the astragalus rests on the superior surface of the navicular at its junction with the internal surface, overhanging the tuberosity; while the posterior border of the inferior surface of the bone is lodged in the interosseous groove on the upper surface of the os calcis. The foot is everted, so that the sole is directed more or less outwards. The head of the astragalus forms a globular swelling on the inner side of the foot, with the skin tightly stretched over it. The inner malleolus is prominent and the outer malleolus buried, the os calcis projecting beyond it. In the dislocation backwards and inwards, the head of the astragalus rests on the outer extremity of the dorsal surface of the navicular and the superior calcaneo-navicular ligament. There is the same appearance of the globular head of the astragalus under tense skin, but it is now situated more to the middle of the dorsum of the tarsus. The foot is inverted, the sole being directly inwards; the outer malleolus is prominent, and the inner buried.

These injuries are liable to be mistaken for dislocation of the astragalus, but may be recognised from it by the unaltered relation of the malleoli to the astragalus, and by the fact that there is no shortening from approximation of the os calcis to the tibio-fibular arch, as there is in complete dislocation of the astragalus.

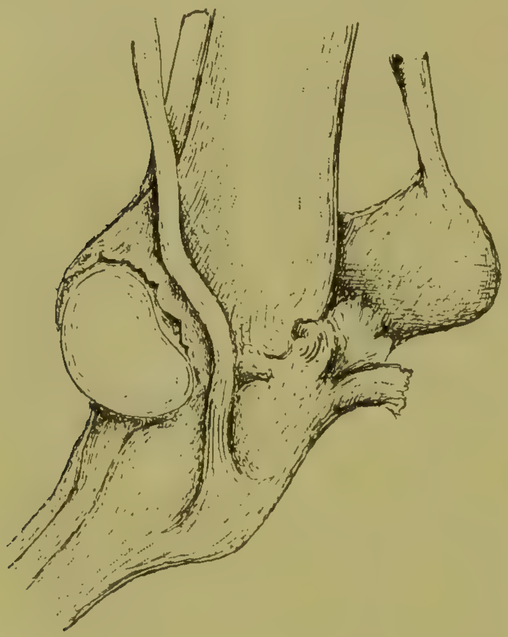


FIG. 188.—Sub-astragaloid dislocation. The neck of the astragalus is embraced by the tendon of the tibialis anticus, which prevented reduction. (From the Museum of St. George's Hospital.)

Treatment.—There is often the very greatest difficulty in effecting reduction in these cases. This is probably due in most cases to the tibialis anticus tendon becoming hitched round the neck of the astragalus (fig. 188), but has also been attributed to the under surface of the neck of the astragalus with its overhanging border becoming locked against the sharp posterior superior border of the navicular bone. It has also been known to be due to a splint fracture of the under surface of the astragalus, against which the posterior inferior margin of the bone becomes wedged.

Reduction is to be attempted by traction. The patient having been anæsthetised, a narrow bandage or skein of wool is fixed tightly around the forepart of the foot just behind the heads of the metatarsal bones. The surgeon, kneeling on the bed, places one knee in front of the lower end of the tibia and fibula and fastens the bandage, whilst in a stooping position, across his back, over one shoulder and under the opposite axilla. By raising the trunk the surgeon can now make forcible extension of the foot forwards, at the same time that his knee makes counter extension, and his hands are free to manipulate the bone into its place. The tendo Achillis and the anterior tibial tendon may be subcutaneously divided if thought necessary. Should this measure fail, treatment must be carried out on the same lines as those indicated in dislocations of the astragalus.

The other tarsal bones may be occasionally displaced from each other. One of the most common dislocations is the one at the medio-tarsal joint, where the rest of the tarsal bones are displaced from the os calcis and the astragalus; or single bones may be dislocated: the os calcis, the navicular, or the internal cuneiform. The cuboid is said to be never displaced alone. These dislocations are often compound. The symptoms are generally obvious. The **treatment** consists in attempting reduction by extension combined with pressure. Should this fail, excision would be called for, especially if the dislocation was compound.

Dislocations of the metatarsal bones and **phalanges** are occasionally met with. They present nothing of a special character either as regards their diagnosis or treatment.

CONGENITAL DISLOCATION

By the term **congenital dislocation** is meant the misplacement of the articular surfaces of a joint, dating from intra-uterine life, and would be perhaps better called congenital *malposition*. These cases must be distinctly differentiated from dislocations resulting from violent or unskilful treatment during the act of parturition. These latter are true acquired dislocations, and have nothing to do with the cases under consideration. Congenital dislocation other than that of the hip is very rare, though cases have been recorded where the condition has been met with in the shoulder, the wrist, and the jaw. It will be sufficient, however, to discuss the condition as it occurs in the hip. Numerous theories have been brought forward to explain this lesion, but the one which seems to account for it best is deficient development of the acetabulum. It is well known that during embryonic life the socket of a joint, like the hip, is formed by a growth of pelvic cartilage round the head of the bone, and that, if this does not take place, no proper cavity is formed, and there is nothing to prevent the displacement of the head of the bone by mechanical action, either the weight of the body, or muscular contraction, or, as thought by some, pressure of the uterine walls from malposition of the limbs during uterine life. As to what is the cause of the arrest of growth of the margin of the acetabulum there is some doubt; but there seems a fair amount of evidence to show that it may be due to lack of proper movement, which may arise from malposition of the limbs; for it is well known that continual movements are necessary for the formation and development of joints.

The most common direction of the displacement is upwards and backwards, so that the head of the bone rests on the dorsum of the ilium above and behind the position of the acetabulum; but displacement upwards and forwards is by no means uncommon. Where the head of the bone rests, a new articular cavity is formed from the thickened portion of the capsule which invests the head, and is therefore not osseous but fibrous. The head of the femur remains small and is frequently indented where it rests against the innominate bone; the neck is shortened and altered in direction. The capsular ligament is much thickened and very capacious, embracing both the new articular cavity and the old, if there is any.

The condition may exist on one or both sides, the proportion being about equal. It is far more common in females than in males, in the proportion of seven to one In many instances a distinct hereditary tendency can be traced.

Symptoms.—The malformation is often not discovered until the child begins to walk, and then the position it assumes and its curious waddling gait draw attention to the subject. The position when standing is one of extreme lordosis (fig. 189). This is due to a disturbance of the equilibrium of the body, the centre of gravity being behind its normal position. On placing the patient in the recumbent posture, the lordosis disappears. The trochanter is always above Nélaton's line, but by traction it can generally be drawn down almost to it. The gait is of a peculiar waddling character. The patient first raises himself on his toes, and then inclines towards that leg which is bearing the greater part of the weight of the body, and slowly brings the other foot forwards. While he does this the body appears to sink on the side to which he is inclined, and if the hand is placed on the prominent trochanter it will be felt to rise, sometimes almost as high as the crest of the ilium. When one hip is only dislocated the lameness in walking is much more perceptible.

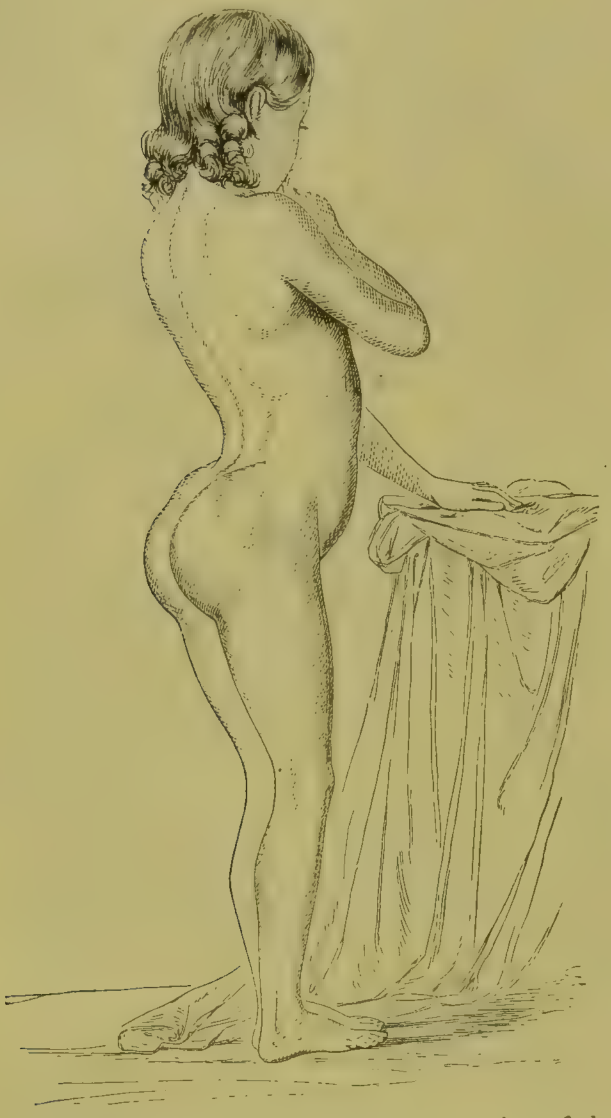


FIG. 189.—Lordosis in congenital dislocation of the hip. (From 'A System of Surgery,' by Holmes and Hulke.)

Treatment.—Various methods have at different times been advocated for the treatment of this condition. They may be classified as follows: (1) prolonged extension; (2) reduction by manipulation; (3) open operation.

Prolonged extension.—This consists in placing the child in a recumbent position on a couch, with a weight extension to the foot, and keeping him there for a long period of time, probably two years, in the hope that by maintaining the head of the bone in or near its normal position, the capsule will be shortened, and a new socket will be formed in the position of the normal acetabulum. This plan of treatment has not proved satisfactory.

Reduction by manipulation.—This can only be done in children at an early age. Probably from two to seven is the best age, but cases have been treated up to the age of fifteen. In those over four it is generally necessary to preface the treatment by extension, and sometimes tenotomy of contracted muscles. This plan of treatment was first introduced by Paci and modified by Lorenz. The first step in the reduction consists in bringing the head of the dislocated thigh down to the level of the acetabulum by extension; the second step, in wedging the head of the femur into the acetabulum. This is done by maintaining the extension and rotating and gradually abducting the thigh. Sometimes the reduction will be accomplished with an audible snap. In order to keep the head of the bone in its proper position, the limb is now put up in plaster of Paris, with the thigh abducted to an angle of 90° with the trunk; for it is found that if this abduction is not maintained, redislocation at once occurs. In two or three days the child is encouraged to walk about with the thigh in this abducted position, with two or three inches added to the sole of the foot on the affected side. The plaster of Paris is allowed to remain on three months and then removed. The abduction is now reduced to an angle of 45°, and the limb is again put up in plaster for three months. At the end of this time, if the position is good, the child is allowed to go about without any support, but with a cork sole on the affected limb to maintain slight abduction, and massage is employed. In double dislocations it is better to operate on one side first, and when this is completed, to proceed to the other.

Open operation.—This was first advocated by Hoffa; but his method, which was founded on wrong principles and was very severe, has been discarded, and the method introduced by Lorenz substituted for it. The operation is performed by first dividing the pelvi-crural muscles, which are shortened; then in gouging out the acetabulum and replacing the head of the bone. The limb being extended, Lorenz first divides the adductor and hamstring muscles. Then he makes an incision about three inches long, vertically downwards from the anterior superior spine of the ilium, divides the fascia lata, sartorius, tensor vaginæ femoris, and anterior fibres of the gluteus medius, and exposes the capsule. The rectus femoris is now divided, and the capsule opened. The thigh is flexed and adducted, and the cotyloid cavity enlarged with a gouge, so as to make it resemble the normal one as much as possible, taking care always to have the upper border left sharp. By a little manipulation the head of the bone can now be inserted into this new cavity. A drainage tube is introduced, the external wound closed, an antiseptic dressing applied, and the parts fixed in an apparatus which maintains the thigh in a position of slight abduction. The operation is necessarily a severe one, and should never be resorted to until the method of reduction by manipulation has been first tried and failed.

PATHOLOGICAL DISLOCATION

Pathological dislocations are the result of some articular affection, such as tuberculous disease, osteo-arthritis, or Charcot's disease. They will be considered with the special diseases in which they occur.

DISEASES OF JOINTS

Diseases of joints are of considerable variety, affecting primarily the different structures which enter into their formation: the synovial membrane, the ligaments, the cartilages, and the bones. But though each of these structures may be the starting point of the morbid condition, it seldom happens that the disease remains confined to this structure without the others becoming involved. Some of these structures—the synovial membrane and the bone—are much more prone to take on pathological processes than the others, viz. the cartilage and ligaments. Indeed, it is rare for disease to occur *primarily* in these latter structures, though secondarily they frequently become involved. In considering the various diseases of the joints it will be convenient to discuss first affections of the synovial membrane, which form a fairly definite class; then diseases of the joint as a whole; thirdly, some other conditions, such as ankylosis, loose bodies in joints, cysts in connection with joints, which may affect any articulation; and finally diseases of special joints.

SYNOVITIS

By **synovitis** we mean an inflammation of the synovial membrane, which is confined to this membrane and does not affect, or affects only to a slight extent, the other structures of a joint. It may arise from either local or general causes, and therefore requires to be considered under two heads.

Non-infective synovitis.—By this is meant inflammation of the synovial membrane set up by injury, such as wounds, blows, sprains, over-use, and exposure to cold, and the disease varies much in its intensity according to the cause. It is therefore customary to describe it as acute, sub-acute, and chronic.

Acute non-infective synovitis, when uncomplicated, is never fatal, but the inflammation may extend to the other structures of the joint and a form of acute arthritis may be set up.

Pathology.—In acute local synovitis the synovial membrane becomes injected and loses its satiny polish, and its fringes are swollen and turgid with blood. The synovial fluid is poured out in increased quantities, so that the cavity of the joint is distended with it. The fluid is at first thin and serous, and then becomes mixed with inflammatory exudation, so that flakes of lymph may be found floating about in it; it also coagulates spontaneously when removed from the joint. Lymph may become deposited on the articular surfaces, and may either later on become absorbed, or may become organised and converted into scar tissue, which forms adhesions and a greater or less amount of rigidity. In favourable cases the whole of these products are absorbed; but in less favourable cases, where the inflammation is more prolonged, the synovial membrane remains thickened and turgid from effused fluid for some considerable time, and it may be permanently.

Symptoms.—The symptoms of acute local synovitis are pain, heat, and swelling, due to effusion into the synovial sac. The *pain* is of a distensile, burning character, and in acute cases is very severe. It is often worse at night and is greatly increased by moving or handling the joint. Upon placing the hand on the part and comparing it with the other side of the body, a sensation of increased *heat* will be experienced, and this is especially noticeable in the superficial joints. The *swelling* is very characteristic as it assumes the shape of the synovial membrane. Thus in the knee there is a swelling extending up the limb for some distance in front of the femur, and more pronounced on the inner than the outer side, and the patella will be felt to float on the fluid. Unless the sac is very tense, a distinct sense of fluctuation will be felt. The limb is generally maintained in a somewhat flexed position, as this causes a certain amount of relaxation of the ligaments, and is therefore the position of greatest ease. Conjoined with these local signs, there is often a considerable amount of constitutional disturbance, with elevation of temperature.

Treatment.—In the treatment of these cases of acute local synovitis rest is of paramount importance. The limb should be fixed on a splint or by bandages in such a manner as to secure complete immobility to the joint, at the same time bearing in mind that a certain amount of ankylosis may result ; so that while the limb is fixed in that position which as far as possible gives the greatest amount of ease to the patient, it must also be secured in that position in which the greatest amount of utility will be obtained in the event of loss of movement being the result of the inflammation.

The application of cold by means of an icebag, Leiter's tubes, or irrigation, is often of the greatest service. Occasionally the weight of the icebag or Leiter's tubes is complained of, and under these circumstances the irrigation of the joint with ice-cold water forms an excellent substitute, if it can be applied without wetting the patient's bedding. Cold must be applied with caution, especially in elderly people. The application of half a dozen leeches over an acutely inflamed joint is often an efficient way of relieving pain and subduing the inflammation. In those cases where these means fail to check the inflammatory process, or where the amount of tension of the joint and consequent pain is very great, the most potent remedy which we have is aspiration of the joint with a carefully sterilised hollow needle. This little operation, which when performed with care is entirely devoid of danger, at once relieves the pain, and may save much time and suffering to the patient. The constitutional treatment consists in a fluid diet while the temperature is raised, and in the administration of saline purgatives, with, in very acute sthenic cases, a little antimony.

Sub-acute synovitis.—Here the causes which lead to this condition are the same as in the acute form of the disease ; indeed, in many cases, especially in debilitated individuals, the sub-acute inflammation may be a sequel of the acute. In some of these absorption of the fluid is very slow, and a collection of fluid remains in the joint cavity, which is known under the name of *hydrops articuli.* In consequence of this the capsular and other ligaments become weakened from over-distension, and a condition of weakness is complained of by the patient. Again, in other cases the fluid accumulation is absorbed, but a certain amount of congestion of the synovial membrane remains, which leads to plastic effusion in the membrane and plastic exudation from it. In these cases the synovial membrane is thickened, and pendulous outgrowths take place from it, which project into the joint and often materially interfere with its functions (fig. 190).

Symptoms.—In cases of sub-acute synovitis there is not much pain, at all events when the joint is at rest; but pain is experienced on moving it, and the patient complains that the joint feels weak and unstable. The amount of swelling is variable: in those cases where the effusion is considerable the swelling is great; it assumes the shape of the synovial sac and is fluctuating. In those cases where there is little or no fluid in the joint, there is still swelling, though considerably less in amount, and it is more solid and without any feeling of fluctuation. On comparing the temperature of the two limbs, there will almost always be found to be a perceptible difference in the heat of the affected joint as compared with the one on the other side, plainly perceptible to the hand placed upon it. This constitutes an important diagnostic sign between an inflamed and an hysterical joint, which in certain features closely simulate one another.

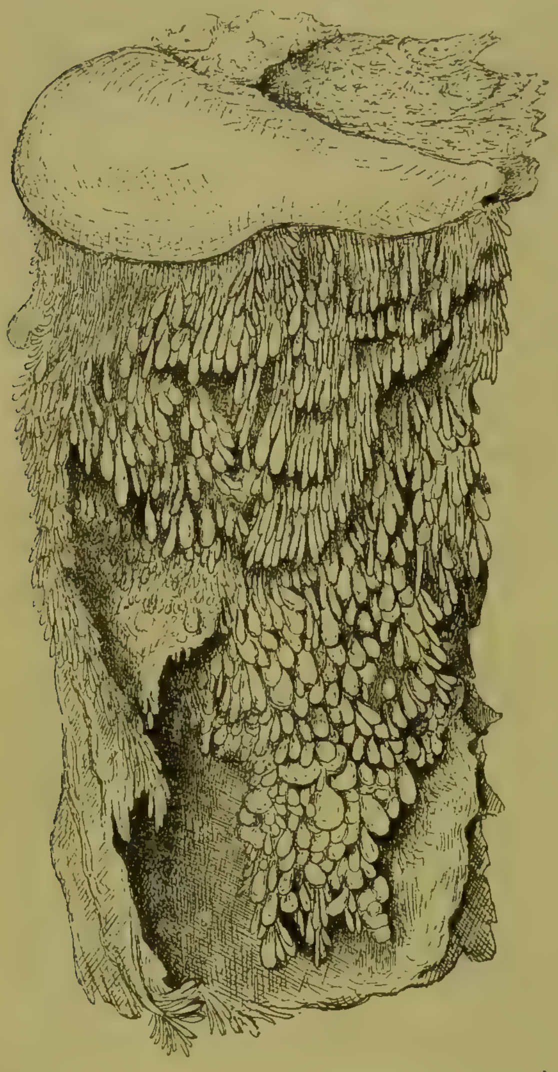


Fig. 190.—Pendulous growths from the synovial membrane of the knee. (From the Museum of St. George's Hospital.)

Treatment.—Here, as in the acute form, rest is the first and most essential indication. In the early stages it may be necessary to confine the patient to bed and secure the leg on a splint when the joint affected is in the lower extremity. Under these circumstances repeated blistering may be had recourse to, and will often prove of the greatest benefit; but it is as well not to confine the patient to bed for longer than can be helped, and he should be allowed to get up and go about with crutches, possibly with a cork sole and heel on the other leg, so as to keep the foot on the affected side clear of the ground; at the same time, means should be taken to immobilise the joint and protect it from any movement. One of the most efficient ways of doing this is by the old-fashioned Scott's dressing (see page 38). By employing this remedy we obtain the sorbefacient effects of the ointment, which promotes the absorption of the fluid; the pressure of the strapping, which also assists in promoting absorption; and the immobility of the joint. In cases of hydrops articuli which resist this plan of treatment, it may be advisable to aspirate, and through the aspirating needle wash out the cavity with hot sterilised water or some weak antiseptic solution, as boric lotion or a weak solution of iodine. The mere aspiration, without the subsequent washing out, is usually not of much avail, as the synovial sac generally fills again.

It should be borne in mind that hydrops articuli may occur in other cases besides those of local synovitis, as in Charcot's disease, osteo-arthritis, syphilitic disease of joints, and in tuberculous disease. In these cases the treatment must be directed to the cause which gave rise to the condition.

Chronic synovitis.—Chronic synovitis is essentially a tuberculous affection, and will be considered with tuberculous diseases of joints. There are, it is true, a certain number of cases, which are classed as chronic simple synovitis, which differ only in degree from the sub-acute form. As they present similar symptoms, though perhaps not so marked; arise from like causes; and as the treatment is the same as in the sub-acute form, they require no further description.

Synovitis arising from general causes.—Under this head we include those cases of synovitis where the inflammation is set up by some poison carried to the synovial membrane through the blood. Of these there are many, including the rheumatic, the gouty, the acute infective, the gonorrhœal, the tuberculous, and the syphilitic.

A word or two will have to be said about the first four of these; the remaining two will be considered with tuberculous and syphilitic diseases of joints respectively.

1. **Rheumatic synovitis** may be acute or chronic. In the acute form it constitutes the disease known as rheumatic fever, and falls under the care of the physician. Its main features are its tendency to metastasis, and to involve more joints than one. Many cases of **chronic** synovitis which fall under the care of the surgeon are no doubt rheumatic in their nature; that is to say, a simple synovitis is set up from a local cause, and then, owing to some rheumatic taint, resolution does not take place, but slight swelling remains, accompanied by a feeling of pain and stiffness upon putting the joint in action after a period of rest. The disease is truly rheumatic in its nature, and there is often a history of a previous attack of rheumatic fever. The pain and stiffness is not always present, but recurs at intervals, is aggravated by cold wet weather, and is worse at night. These symptoms may last for years, recurring at intervals. In some cases the disease may not be confined to the synovial membrane, but involve the other structures and go on to disorganisation of the joint. These cases must be distinguished from osteo-arthritis, with which they are apt to be confounded.

The **treatment** consists in correcting the constitutional condition by change of residence to a dry warm climate; by courses of baths at Buxton and Bath in this country, or Aix-les-Bains and Wiesbaden abroad, and by the administration of anti-rheumatic remedies, with iron and cod-liver oil to support the general health. The local treatment consists in friction with various stimulating liniments, or the application of anodynes, as a mixture of chloroform, belladonna, and glycerine, and swathing the part in a flannel roller. Hot soda fomentations are sometimes very efficacious in relieving the pain and stiffness.

2. **Gouty synovitis** is another form of synovitis which falls under the care of the physician, and therefore does not require a lengthy description in this work. It usually attacks a single joint, most frequently the metatarso-phalangeal joint of the great toe (podagra), but it also not unfrequently attacks the corresponding joint of the thumb (chiragra) and the knee (gonagra). The disease consists in the sudden onset of an acute inflammatory process in the joint, evidenced by intense pain, redness, and swelling from effusion into the joint. This is always accompanied by the deposit of urates in the matrix of the cartilage. As attacks are repeated the deposit increases, until it forms considerable masses, which infiltrate all the structures entering into the formation of the joint. In this way the articulation becomes permanently enlarged and deformed, and quite rigid and stiff. Sometimes the skin over the swollen joint gives way, and a discharge of a chalky material takes place.

The **treatment** consists first of all in careful dieting and the administration of colchicum, citrate of lithia, and saline purgatives. Locally the application of glycerine and belladonna with a hot fomentation will be most grateful to the patient. After the attack he must be carefully dieted to prevent a recurrence. He should avoid all fats and rich foods, pastry, sweets, and sugar, and his diet should consist of poultry, fish, fresh vegetables, toast or stale bread, and skimmed milk, with plenty of fluid, especially hot water, night and morning. He should take regular exercise. A free action of the skin, bowels, and kidneys should be maintained. In the way of stimulants, nothing should be taken except a little whisky or claret.

3. **Acute infective synovitis.**—This condition is met with in the course of many infective diseases, as in pyæmia, in puerperal fever, in scarlet fever, smallpox, typhoid fever, and dysentery. Hitherto these conditions have been regarded as distinct from each other, but they are probably closely allied and due to the same cause—the presence in the blood of one of the different forms of cocci which have been introduced into it from the local lesions of the various diseases which have been enumerated: from the septic wound in pyæmia; from the placental surface of the uterus in puerperal fever; from the ulcerated throat in scarlet fever; from the pustules in smallpox; and from the ulcerated intestine in typhoid fever and dysentery. It is brought about by the irritating effects of the micro-organisms or their products upon the synovial membrane.

The disease begins suddenly with a rapid swelling from effusion into the joint. The effusion, at first consisting of simply altered serum, speedily becomes turbid and purulent. The inflammation extends to the ligaments and the cartilages, and acute arthritis is set up. This rapidly terminates in complete disintegration of the joint.

Symptoms.—The local signs are those, to a certain extent, of acute local synovitis. There is sudden swelling, which follows the shape of the synovial sac; there is acute pain and heat of the joint. But the pain soon becomes of a throbbing character; the skin over the joint becomes of a dusky, patchy hue, and there is œdema of the subcutaneous tissues. The disease frequently attacks more joints than one. The constitutional symptoms are of a different type to those seen in acute local synovitis. There are rigors, often repeated; a high but oscillating temperature; delirium; rapid emaciation; and increasing debility, with often diarrhœa and vomiting; in fact, all the symptoms which denote an attack of acute septicæmia (page 167).

Treatment.—The treatment consists in laying the joint freely open and thoroughly washing away every trace of the irritating fluid by flushing with large quantities of weak antiseptic fluid or hot sterilised water. If this is done in quite the early stage of the disease, before any destructive changes have set in, it may be possible to arrest the progress of the inflammation, and the patient may recover, with the movements of the joint but little impaired. What more generally happens is that a considerable amount of contraction and thickening of the capsule is left, and the functions of the joint are very much interfered with. But in the majority of cases, in spite of the most thorough flushing of the joint, the disease goes on to total destruction of the articulation, if the patient lives; for in many of these cases the patient succumbs to the presence of septic matter in the blood. The general treatment must be conducted on the lines laid down in speaking of the treatment of septicæmia.

4. **Gonorrhœal synovitis.**—This form of synovitis is also possibly due to an infective cause operating from within through the blood. But it differs in some respects from those cases of acute infective synovitis which we have just been considering. It rarely if ever runs on to suppuration; those cases in which gonorrhœal synovitis does run on to this condition being probably pyæmia, due to the infection by pyogenic organisms. It is supposed to be brought about by the infection of the synovial membrane by gonococci (the micrococci gonorrhϾ), carried from the urethra by the blood stream; but this is by no means certain, for, as far as we know, this gonococcus is aërobic and cannot be propagated in the blood; and though Petrone and Kammerer are said to have found the micro-organism in the fluid of a knee joint in a case of gonorrhœal rheumatism, this observation has not been confirmed by others.

Symptoms.—The disease in the great majority of cases affects the knee, though other joints, especially the ankle and the wrist, are affected at the same time. It usually occurs in the young adult, and is much more common in the male than the female. It is said to especially attack the rheumatic or gouty subject, and generally occurs in weak anæmic men. The disease generally commences somewhat insidiously with pain in one or more joints; the pain is not usually very acute, but is constant and is worse at night. This is accompanied by swelling, due principally to infiltration of the tissues around the joint, with a small amount of effusion into it. In other cases the disease begins much more suddenly, with acute pain and considerable effusion into the joint. Accompanying these local signs there is always a certain amount of constitutional disturbance. In the acuter cases, when there is rapid effusion, this is often considerable; but even in the less acute form, a slight nightly elevation of the temperature, with accelerated pulse and furred tongue, will be noted. The disease is very chronic and intractable, and is liable to terminate in permanent stiffness of the joint from fibrous adhesions taking place within it.

Treatment.—The first indication in the treatment is to stop the discharge from the urethra; until this is done and the cause of the articular trouble is removed, there can be no prospect of cure. The disease is not usually set up until the gonorrhœa has assumed the sub-acute or gleety stage, and the usual remedies for this should be administered. In my hands the introduction of an iodoform and oil of eucalyptus bougie (gr. v of each) into the urethra every night, for five or six nights, has been attended with good results. Internally the best remedies are quinine and iron. Patients suffering from gonorrhœal rheumatism are almost always anæmic, and a tonic plan of treatment is therefore indicated. Iodide of potassium is often recommended, but owing to its depressing effects it very often proves worse than useless. I have seen in these cases good results follow the internal administration of carbolic acid combined with quinine. Minim doses of liquefied carbolic acid are given with two grains of quinine, two minims of dilute sulphuric acid, a drachm of glycerine and water, three times a day. The patient should have full diet, and very often a couple of glasses of stout daily will prove of benefit to him.

ARTHRITIS

By **arthritis** is meant an inflammation of all the structures of which the joint is composed. It may commence in the synovial membrane, and from it may extend to the other structures; or on the other hand it may begin in the bones or in the soft parts around the joint, and the synovial membrane become secondarily affected. In its acute form it rarely begins in the ligaments or cartilages, but one variety of chronic arthritis—osteo-arthritis—begins for the most part in the cartilages.

Acute arthritis may begin in the synovial membrane, either as (1) a rheumatic synovitis, which may spread to the other structures and occasion disorganisation of the joint; or (2) a septic synovitis, from the introduction of septic material from without through a wound (see page 494); or (3) an infective synovitis, from the introduction of organisms from within through the blood (see page 534); or acute arthritis may result from disease of the soft parts external to the joint. In acute bursitis, for instance, running on to suppuration, or in phlegmonous erysipelas of the tissues over a joint, pus may find its way into the cavity of the joint, and acute arthritis, going on to total destruction of the joint, follow. Finally, acute arthritis may result from disease of the bones in the neighbourhood. This is especially the case with the acute arthritis of infants, which will be described in the sequel.

Symptoms.—The symptoms of acute arthritis are pain, heat, swelling, and redness, with fixation of the joint in a particular position. The pain is very severe, and is greatly increased upon the slightest movement; even jarring the bed or shaking the room by walking across it with a heavy step is so exquisitely painful as to cause the patient to scream with agony. When the cartilages become eroded and the articular surfaces of the bones exposed, there are painful startings of the limb at night. As soon as the patient drops off to sleep the muscles become relaxed and thrown off their guard, thus allowing the inflamed surfaces to move slightly on each other, and causing the most excruciating pain and a sudden reflex contraction of the muscles which wakens the patient and causes a scream of agony. The heat about the diseased joint is considerable. The swelling is not generally very great except perhaps in the early stage, when the inflammation is confined to the synovial membrane and has not spread to the other structures. It is uniform, and is due in a great measure to inflammatory exudation into the capsule and the structures external to the joint. In the early stage, in joints which are superficial, there is more or less bright redness of the skin over the joint; while later on, in those cases which run on to suppuration, the skin becomes of a more dusky hue. The position which the limb assumes is peculiar. It is always more or less flexed—in that position in which the ligaments are most relaxed and which is therefore the position of greatest ease to the patient. The limb is fixed in this position by reflex contraction of the muscles, and any attempt to move it is attended with the greatest pain.

The termination of this condition may be in resolution. The symptoms gradually subside, and the patient recovers in most instances with an ankylosed joint. More commonly the disease runs on to suppuration. The joint becomes filled with pus, which bursts through the capsule, and may either find its way to the surface or burrow through the tissues of the limb. The ligaments becoming destroyed, the bones move more freely on each other, and actual displacement may take place. Sinuses now form in every direction, and the disease becomes chronic, the patient frequently succumbing to hectic and lardaceous disease unless amputation is performed. The case may, however, terminate fatally during the acute stage, from pyæmia or septicæmia.

The pathological changes which take place in the various structures of the joint have already been alluded to in speaking of arthritis from a septic wound (page 494).

Treatment.—The most essential points in the treatment of acute arthritis are rest and extension. The limb must be put up in some efficient splint which will keep the joint perfectly immobile and not allow of the slightest movement between the two joint surfaces. In addition to this, means must be devised to separate the articular surfaces from each other. As long as the two surfaces are pressed together by the spasmodic contraction of the muscles, the destructive disorganisation will go on and the pain will continue; but if extension is made, which can generally best be done by a weight extension attached to the limb below the affected joint, the pain will often be at once relieved, the painful startings of the limb at night will not occur, and the pressure of the inflamed articular surfaces on each other being removed, this cause of unrest to the joint will be done away with, and a great step will be gained towards the cure of the patient. In adjusting the splint, it must always be borne in mind that ankylosis may be the outcome of the case, so that the limb must be put up in such a position that, if ankylosis does ensue, it will be of the greatest use to the patient. The local application of warm Goulard lotion and opium is often comforting to the patient. Should these means fail in arresting the disease, and evidence of suppuration show itself, the joint should be laid freely open on either side and thoroughly irrigated with a weak antiseptic solution or hot sterilised water, and a drainage tube inserted. Any abscesses outside the joint must be similarly treated, and the limb maintained in the fixed position. The irrigation of the joint must be continued daily, and strict antiseptic precautions observed. Under favourable circumstances recovery may take place with an ankylosed limb. The discharge lessens and becomes thinner and more serous; the temperature falls to normal, and eventually the wounds heal. But in most of these cases the prognosis is not favourable: either decomposition sets in, and pyæmia is developed; or the continuous discharge is followed by a condition of chronic septic poisoning (hectic fever), and is accompanied or followed by lardaceous disease, and death is the result unless amputation or excision is performed. The cases in which excision can be done are very few; but now and then cases do occur in which the peri-articular structures are not much involved and where the disease is principally confined to a rarefying ostitis of the ends of the bone and has become quite chronic, in which the operation of excision may be undertaken.

Acute arthritis of infants is the name given by Sir Thomas Smith to an acute inflammation of joints rapidly running on to suppuration. It generally occurs in infants under twelve months of age, and would appear to be, in most cases, a sequel to acute epiphysitis (page 474). Epiphysitis is first set up, and the pus formed at the growing end of the shaft of the bone burrows its way either through the epiphysis or through the soft parts surrounding it, and bursts into the joint, setting up an acute suppurative arthritis. The disease most commonly occurs in the shoulder, the hip, and the knee. The symptoms in the first place are those of epiphysitis, and the implication of the joint is indicated by sudden swelling from effusion into the synovial sac. This is followed by serious general symptoms. The temperature rises to 103° F. or more; the child becomes sallow and wan, refuses its food, and is often sick: it is frequently convulsed, and, unless actively treated, speedily dies either from pyæmia or exhaustion. The treatment has been described in the chapter on diseases of the bones, in connection with epiphysitis (page 474).

OSTEO-ARTHRITIS

Osteo-arthritis appears to be the best designation for a disease which is very common in this country, and has been known by many different names, such as chronic rheumatic arthritis, rheumatoid arthritis, arthritis deformans, and rheumatic gout. At all events, it seems desirable to keep the name 'rheumatic' out of its appellation, as the view most generally held at the present time appears to be that it is a disease quite distinct from rheumatism, and therefore the introduction of the prefix 'rheumatic' is misleading and tends to cause it to be mistaken for those cases of true rheumatic arthritis which have already been described.

Osteo-arthritis is a disease which usually commences in middle life, and is essentially chronic, continuing throughout the rest of the life of the patient. It occurs in both sexes, and is generally confined to one joint, but may attack several, one after another. All joints are liable to it, but the hip, the knee, the shoulder, and the temporo-maxillary joint are especially liable to be affected. It is said that the hip joint is more commonly affected in the male, and the knee in the female. A peculiar variety is when it attacks the smaller joints, especially the joints of the fingers; this is usually in anæmic females, and generally commences at a much earlier age than the ordinary form. The vertebral joints are also not unfrequently the seat of this disease.

Causes.—The causes of osteo-arthritis are very obscure. It is usually believed to be due to some form of malnutrition, and to be predisposed to by any depressing influence, either mental or physical. There seems to be very good reason for believing that in many cases defective innervation is the exciting cause, and that this is set up by peripheral neuritis or some other degenerative change in the nervous system. There can be no question, also, that exposure to damp and cold, and especially residence on a clayey soil, predisposes to this disease, on account of the common occurrence of the disease in those who are exposed to these conditions, and also on account of the relief which is afforded by a change of residence to a drier and warmer climate. Quite recently it has been asserted that the disease is due to a micro-organism, and Bannatyne has described a bacillus which he has found in the joints of patients suffering from this disease. These observations require confirmation before the theory can be accepted.

Pathology.—The morbid process in osteo-arthritis begins in the articular cartilage. This becomes of a dull yellow, opaque appearance, and loses its smooth polished surface, and appears velvety. If examined microscopically, this change is found to be due to a fibrous transformation of the matrix and a proliferation of the cartilage cells. On thin sections being made, the matrix will be found to consist of fibrillæ arranged vertically to the surface, and the primary capsules enlarged and containing more than one cartilage cell. In consequence of these morbid processes the cartilage becomes softened and two changes occur in it. In the centre of the articular surface, where there is the greatest amount of friction, the cartilage becomes worn away and the bone exposed; at the margins of the cartilage, where there is least pressure, there is an overgrowth of this structure and the formation of an irregular nodular lipping or thickening. The nodules of which this thickening is composed undergo a process of ossification, and in this way the joint comes to be surrounded with a number of bony outgrowths, which are also nodular and rounded, and have been compared by Billroth to the drippings of a tallow candle. Where the bone has become exposed by the wearing away of the softened cartilage, it undergoes sclerosis, a form of ostitis with excessive calcification; so that it becomes hard and porcellanous (eburnated) in appearance, and, from the movements of the joint, smooth and polished on its surface (fig. 191). In spite, however, of this eburnation, which does not extend very deeply, the bony surface becomes worn away, a fresh eburnation taking place in the tissues immediately beneath. In hinge joints this wearing away produces a very peculiar appearance, arising from the movements of the joint in one direction only. If, for instance, the ends of the bones entering into the formation of the knee joint are examined in a case of advanced osteo-arthritis, they will be seen to present an undulating surface composed of alternate ridges and furrows running in an antero-posterior direction.

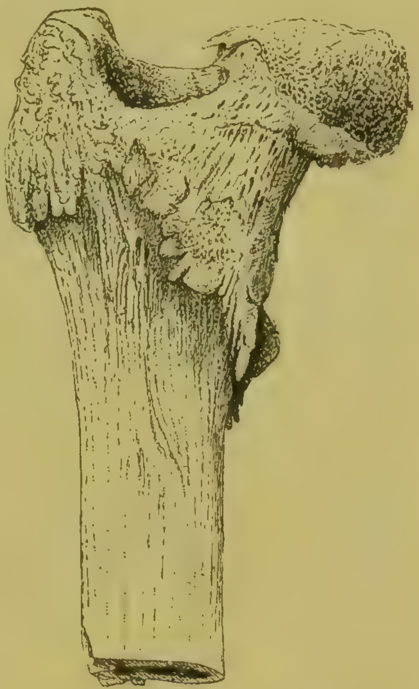


Fig. 191.—Osteo-arthritis of the hip joint. (From the Museum of St. George's Hospital.)

In the early stages of the disease the synovial membrane becomes more vascular, thickened and swollen. The villi become increased in size and give off secondary processes, so that the interior of the joint may sometimes contain a large number of pendulous growths, which attain a considerable size. Occasionally chondrification and ossification take place in these pendulous bodies, and if they subsequently become detached they constitute one form of 'loose bodies' in a joint. In some cases, especially in the earlier stages, there is an increased amount of synovial secretion ; but this is by no means a constant condition, and as a rule the disease is essentially 'dry' throughout its course. As the disease advances the capsule becomes thickened, and bony outgrowths spring up from the periosteum of the adjacent bone, producing greater deformity than that which already exists, and further interfering with the movements of the joint, which may have been already seriously interfered with by the interlocking of the osteophytes springing from the articular cartilages. It must be borne in mind, however, that no true ankylosis takes place, and no fusion between the outgrowths, though they may be firmly wedged one into the other. The eburnation spoken of above as taking place on the articular surfaces does not extend deeply, and the bones below are of a more open texture than natural and filled with yellow fat. In consequence of this the bones become much altered in shape. The rounded heads of the long bones, as the humerus and femur, become flattened out and expanded, and the neck shortened, so that they assume the shape of a mushroom. The cavities with which they articulate become enlarged and flattened.

Symptoms.—The symptoms of osteo-arthritis are pain, rigidity, deformity, and crepitus or grating. The *pain* is not very great in the earlier stages of the disease, but later on it becomes of a peculiarly wearing, aching character, being worse at night and in damp weather. The *rigidity* at first is slight; it will be found that the patient is unable to flex and extend the joint to the same extent as on the opposite side, and if this is attempted, pain is induced. Subsequently, the growth of the additamentary bones interferes with the movements more and more, and if they become interlocked with each other, movement is almost entirely arrested. The *deformity* may be due in the earlier stages to effusion into the joint, if there is any ; but as the case progresses it is caused by the alteration in the shape of the bony surfaces, and to the formation of the osteophytic outgrowths around the joint. The *crepitus* is at first merely a slight creaking on movement; but when the cartilages are eroded it is a true bony grating, caused by the rubbing together of the exposed bony surfaces, and is sometimes so loud that it can be heard all over the room.

Treatment.—The treatment of this complaint when it is fully established is never very satisfactory. When structural changes have taken place, they cannot be repaired ; but in the early stages much may be done to arrest the rapid progress of the degenerative changes. The most potent means of giving relief is by sending the patient to reside in a dry warm climate and improving the general health by a light digestible diet, fresh air, and tonics, especially arsenic, at the same time keeping the bowels freely open by gentle laxatives, and the skin acting by warm clothing, Turkish baths, &c. The joint affected should be protected from cold by a flannel bandage, but its movements should not be restricted, as this causes it to become fixed sooner than it otherwise would have been. When changes have taken place in the joint, as indicated by alteration in the joint surfaces and in the loud grating on movement, much may be done to relieve the suffering. Hot-water douches are very beneficial, and rubbing the joint with stimulating embrocations is attended with good results. If pain is very severe it may be relieved by sedative applications, such as opium and belladonna. Iodide of potassium given internally will often relieve the pain, but it is better to avoid giving it, at all events for any long period of time, on account of its depressing effects. Natural mineral waters and baths, especially those of Wildbad in Germany, Aix-les-Bains in Savoy, and Bath, Buxton and Harrogate in this country, are said to do good, and are often recommended.

In some cases excision has been performed for osteo-arthritis. Such operations are, however, rarely called for, inasmuch as they should never be done except in those cases where the patient is seriously crippled by his disease and one joint only affected; for it must be borne in mind that the disease is liable to recur in another joint after the affected one has been successfully removed. Probably the case in which the operation is most called for is in osteo-arthritis of the temporo-mandibular joint, seriously interfering with the process of mastication.

CHARCOT'S DISEASE

A form of arthritis, very similar to osteo-arthritis, but occurring in connection with locomotor ataxy, has been described by Charcot, and usually goes by his name or the name of *Tabetic arthropathy*. The disease is believed by Charcot to be due to degenerations in the nervous system producing trophic changes in the bones and other tissues of the joint. Whether this is so or not, it often commences when the tabetic symptoms are but little marked and before there are any signs of want of co-ordination in the muscles of the limb. In the majority of cases it begins with a sudden painless effusion into the joint of a transparent fluid of a pale lemon colour. The fluid not only distends the joint but also any bursæ which may be in the neighbourhood, and the soft tissues around. In a small proportion of cases the fluid is gradually absorbed and the joint recovers; but in the majority, changes go on in the articulation which result in its complete destruction.

The joints most frequently affected are the shoulder, the hip, and the knee, and as a rule only one articulation is involved; but occasionally more than one joint is affected, usually the corresponding joint on the opposite side of the body. It affects both sexes, but is slightly more common in the female than the male. In many cases some slight strain or injury appears to be the exciting cause of the disease.

Pathology.—The pathological changes found after death are very similar to those found in osteo-arthritis, except that the lesions in the bones are much more extensive and the formation of osteophytic outgrowths much less or altogether wanting. The fibrillation and wearing away of the cartilages, the erosion of the bones, and the destruction of the ligaments are the same in the two diseases. But the erosion and wearing down of the bones are much greater in Charcot's disease than in osteo-arthritis; so much so, that in some cases the whole of the articular surfaces may be worn away, and from this cause, as well as from the stretching and destruction of the ligaments, dislocation is very liable to take place. It must be mentioned also, that though as a rule the formation of ossifying cartilaginous outgrowths is very limited, large masses of bone are sometimes formed in the synovial membrane, and these, when there is much effusion, give to the hand the sensation of grasping a bag of bones.

Symptoms.—The surgeon is usually consulted in these cases because a joint has become suddenly enormously swollen and tense, it may be, after a slight injury. Not only is there effusion into the joint, but also swelling of the surrounding tissues (fig. 192). This is not accompanied by pain or fever. Later on, the swelling in the soft parts disappears, but the effusion in the joint persists, though it may become diminished. At this stage, grating on movement will be perceptible, and extreme mobility of the articulation, especially in the hinge joints, in a lateral direction. A flail-like joint now results, and great unsteadiness in walking if the disease is in the lower extremity. Dislocation may now ensue. Conjoined with these local signs there is always more or less evidence of locomotor ataxy. The principal symptoms of this are: want of co-ordination in the muscles of the limbs; inability to stand steadily or walk with the eyes shut; absence of the patellar reflex; the 'Argyle Robertson pupil,' i.e. loss of reaction of the pupil to light, while it accommodates itself for near vision; lightning pains in the limbs and joints; a history of so-called gastric crises; loss of sexual power; incontinence of urine; diplopia, or other disorders of vision; and other symptoms which will be found described in works of medicine.

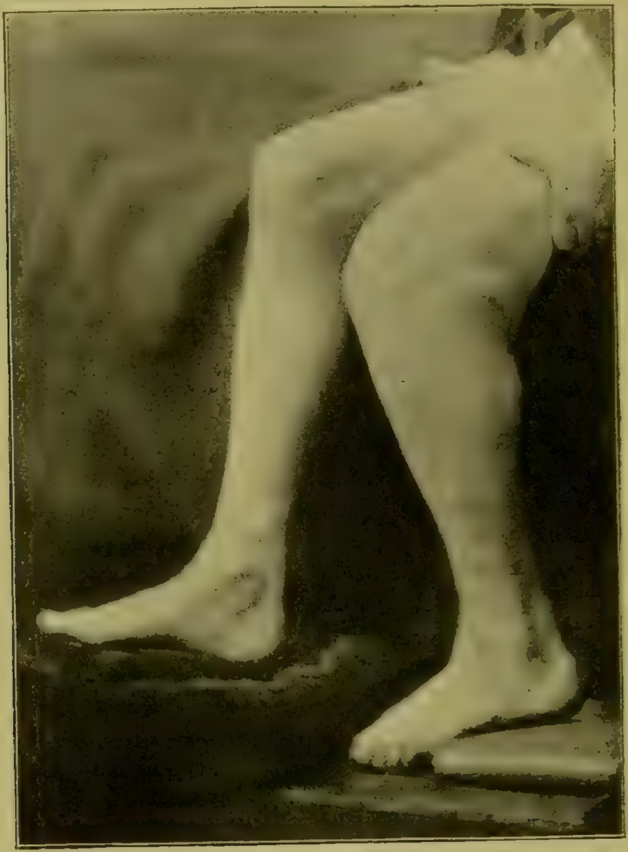


Fig. 192.—Photograph showing the deformity in Charcot's disease of the knee. (From the Museum of St. George's Hospital.)

Diagnosis.—The diagnosis of ataxic arthropathy from osteo-arthritis may be generally made by attention to the following points. In the former the onset is sudden, is attended with considerable effusion, and is painless; in the latter the onset is gradual, is rarely attended with much effusion, and is painful. In Charcot's disease dislocation is common; in osteo-arthritis it is rare. The progress of the two diseases is also dissimilar: in the former it may be arrested or may subside entirely, in the latter the disease is progressive and generally permanent. In addition to these distinctive signs in

Charcot's disease, symptoms of tabes dorsalis are always present to a certain extent, though in some cases they may not be well marked.

Treatment.—The treatment of this disease must be directed to the general condition which gives rise to it, and this necessarily falls under the care of the physician. Locally relief may be given by careful elastic bandaging, which promotes absorption of the effused fluid. Aspiration is useful to relieve the distended joint, but the fluid rapidly accumulates. The combination of aspiration with elastic pressure is the best means of treatment: the joint is first emptied and a Martin's elastic bandage at once applied; this will in a great measure prevent the reaccumulation of the fluid. Later on, when the joint has become flail-like, some suitable splint must be devised in order to give it support.

In connection with this subject it must be mentioned that in some other forms of degenerative changes in the spinal cord, and also in some cases of peripheral neuritis, a very similar condition of joints to tabetic arthropathy is set up. But, in these cases, accompanying the effusion there is also considerable pain and other indications of an inflammatory condition which serve to distinguish them from Charcot's disease.

SYPHILITIC DISEASE OF JOINTS

Syphilitic disease of joints is not common considering the great prevalence of syphilis; nevertheless there is a distinct and well-defined disease of joints occurring in tertiary syphilis and due to a gummatous infiltration of the synovial membrane; and, in addition to this, there is a condition of sub-acute synovitis due to the same disease, which is occasionally met with in the secondary stage of the disorder.

Sub-acute synovitis in secondary syphilis.—This condition occurs early in the secondary stage of syphilis, and is due most probably to the irritation of the syphilitic poison. It appears generally before the eruptions make their appearance, and is characterised by pain, more especially at night, and some slight effusion into the joint. It most commonly attacks the knee. It usually subsides after a time, but sometimes is very intractable.

Tertiary syphilitic disease of joints usually begins in the synovial membrane as a diffused small-celled infiltration. Occasionally the infiltration may be localised and the cells collected into a mass, and then there is a true gummatous formation; but as a rule the infiltration is diffused evenly through the tissues. This may undergo various changes. Under treatment it may undergo resolution, and the part return to its natural condition; or before resolution takes place it may have undergone a fibroid organisation, under which circumstance a more or less permanent thickening of the tissues will remain. On the other hand, degenerative changes may ensue: the infiltrated material may undergo fatty degeneration and become caseated, and this may subsequently dry up and cretify; or it may undergo liquefaction and form masses of pulpy broken-down material, which may ulcerate through the skin and discharge, or open into the joint and lead to its ultimate disorganisation.

Symptoms.—The disease is very insidious in its earlier stages. There is merely a little feeling of weakness, scarcely amounting to pain, so that the patient continues to use his joint for some time after the disease has fairly commenced. There is some swelling of an elastic nature, and very often localised to some part of the joint, and not forming a globular enlargement of the whole joint, as in the tuberculous form of disease, with which it is apt to be confounded. There is some limitation in the movements of the articulation, but no increased redness or appreciable increase in the heat of the part. Later on, if softening takes place, the swelling becomes more doughy and eventually fluctuates, the skin becoming discoloured and of a purplish hue. Conjoined with this is the history of syphilis and probably the evidence of syphilitic lesions in other parts of the body.

Treatment.—The treatment of this condition consists in the administration of iodide of potassium or sodium, and improvement of the general health by tonics, change of air, and carefully regulated nutritious diet. The tonics especially indicated are iron and cod-liver oil. The local treatment consists in the earlier stages of hot douching and massage, with some form of splint to support the joint and restrain its movements. In a considerable number of cases this treatment is attended with very satisfactory results, and the disease subsides, with or without permanent thickening.

The disease is met with in the hereditary as well as in the acquired form of syphilis, and in the former the administration of a course of mercury is indicated.

In congenital syphilis the disease shows itself in joints in another way. Not unfrequently a child with evident traces of inherited syphilis will be brought under the notice of the surgeon with passive effusion in two symmetrical joints, generally the knees. The effusion is usually unattended with pain, and there is little or no thickening of the synovial membrane or capsular ligament. It is an example of hydrops articuli, spoken of above (page 531). The great characteristic of the disease is the uniformity with which it attacks the corresponding joint on the two sides of the body. This and the evidence of inherited syphilis establish the diagnosis. The disease is very intractable, and leads to weakening and instability of the joint from stretching of the ligaments. A marked feature in these cases is the variation in the amount of fluid which takes place: at times it will diminish very considerably, and it will appear as if resolution were about to follow, and then, without any assignable cause, a fresh effusion will occur. The treatment of these cases consists in administering a prolonged course of mercury and careful bandaging, to promote absorption by pressure, and support the weakened joints.

TUBERCULOUS DISEASE OF JOINTS

Tuberculous arthritis may commence in the synovial membrane, when it is known as *pulpy degeneration*, or in the ends of the long bones entering into the formation of the joint. In addition to this, tuberculous arthritis may be the result of a tuberculous condition of the tissues in the neighbourhood of a joint, extending by continuity of structure to the articulation. Thus tuberculous bursitis may terminate in general implication of the joint in the neighbourhood of the bursa.

Tuberculous synovitis is that form of disease which is popularly known under the name of *white swelling*, and is a very common disease in this country among children.

Pathology.—The disease is generally the result of some slight injury of which perhaps little or no notice is taken at the time, but which in a child, predisposed to tuberculous disease, produces such an alteration in the tissues that they form a suitable nidus for the development and growth of the tubercle bacilli, which, carried by the blood, become deposited in the membrane and there grow and multiply, and produce a series of degenerative changes which constitute the disease. These changes are the result of an inflammation set up in the synovial membrane by the presence of this particular organism. The membrane becomes thickened, pulpy, and more vascular, and on microscopic examination will be found to contain nodules consisting of a central 'giant cell' surrounded by epithelial cells, embedded in a mass of round cells, and thus constituting a true tuberculous nodule (fig. 193). As the disease advances the synovial membrane disappears, and is replaced by granulation tissue. This gradually invades the joint; it fills up its interstices and pouches, and creeps over the cartilages (fig. 194). The inflammatory changes extend to the capsule and ligaments, which in turn also become destroyed and converted into granulation tissue; so that now, if a section through the joint is made, the position of the synovial membrane will be found to be occupied by a soft pinkish-grey-coloured gelatinous material, sometimes an inch or more in thickness. If the processes of granulation tissue which can be seen spreading over the cartilage are examined a little more attentively, it will be found that at their distal extremity they are simply lying on the cartilage; a little farther back—that is to say, nearer to the point from which they sprang—they are adherent to the cartilage, and still farther back they have eaten into the cartilage and are gradually replacing it. As this process goes on, the granulation tissue eats through the whole thickness of the cartilage and perforates it. When this is accomplished, it begins to spread on its under surface between it and the bone. It thus cuts off the nutritive supply to the cartilage, and causes necrosis of the remains of the partially destroyed tissue. As the granulation tissue creeps along the under surface of the cartilage, it attacks the bones, and a condition of rarefying ostitis is set up, which may extend for a varying distance into the cancellous tissue of the ends of the bones forming the joint. In this way destruction of all the tissues entering into the formation of the joint takes place; the parts in the neighbourhood become involved, and when

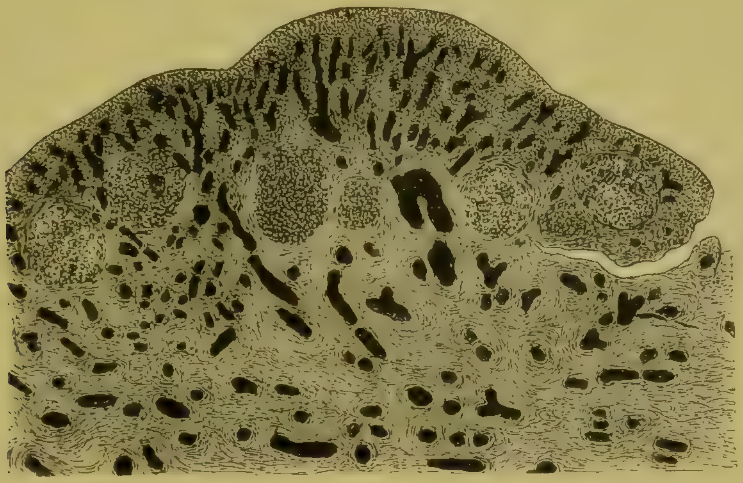


FIG. 193.—Miliary tubercle of the synovial membrane, from a case of tuberculous arthritis. (From Holmes's 'Principles and Practice of Surgery.')

the bones are implicated the periosteum is included in the inflammatory changes. The inflammation in this structure is sometimes to a certain extent of a developmental, rather than of a destructive, character, and goes on to the formation of osteophytic outgrowths around the joint. These outgrowths are very dissimilar from those found in osteo-arthritis; instead of being rounded and nodular, they are sharp and pointed, like stalactites. Their mode of formation is also dissimilar: the outgrowths in osteo-arthritis are formed by the ossification of cartilage, those in tuberculous disease by developmental changes taking place in granulation tissue. This formation of osteophytes in tuberculous disease is by no means of constant occurrence.

After the granulation tissue which has replaced the natural tissues of the joint has attained a certain thickness, it begins to undergo degenerative changes from malnutrition. These changes begin in those parts which are farthest removed from the blood supply, and consist in a process of fatty degeneration and caseation of the tissue, which eventually liquefies, and thus caseous foci filled with curdy material are formed in the substance of the granulation tissue. As the disease progresses, the degenerative changes implicate more or less the whole of the granulation tissue, the localised caseous foci coalesce, and the whole joint is converted into a caseous cavity containing the remains of the broken-down tissue and bounded by the carious ends of the bones entering into its formation. It must be borne in mind, however, that sometimes these caseous foci may not implicate the joint, but may form extra-articular abscesses, which discharge externally without opening into the joint cavity. This, however, is not common, and, as a rule, the caseous foci penetrate the joint and the whole articulation is destroyed.

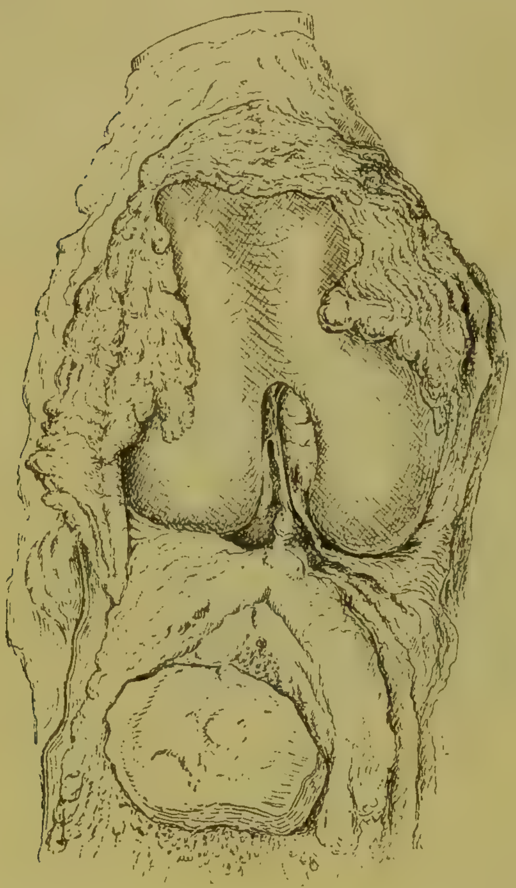


FIG. 194.—Tuberculous disease of the synovial membrane of the knee joint, showing the granulation tissue creeping over the cartilage. (From a drawing in the Museum of St. George's Hospital.)

Tuberculous arthritis commencing in the bones.—The disease in these cases commences as a deposit of tubercle in the bone, and around this destructive changes take place, such as have already been described in speaking of tuberculous disease of bone (page 478). The deposit most frequently takes place in the vascular growing bone in the neighbourhood of the epiphysial cartilage, and is often the result of a slight strain or wrench, which causes a certain amount of change in the tissues which renders them suitable for the growth of the bacillus. The disease may invade the joint by two different routes. In those cases where the epiphysial cartilage is situated within the capsule of the joint, as in the hip, the disease may extend to the surface of the bone, and when it reaches this, being within the capsule, it may infect the synovial membrane and an arthritis may be set up. In other cases the disease may spread through the cancellous tissue of the epiphysis until it reaches the under surface of the articular cartilage; this it perforates by the formation of granulation tissue which destroys and replaces the cartilage, and when perforated the synovial membrane becomes infected. In whichever way the synovial membrane is involved, the changes which take place in it are similar to those which take place in tuberculous arthritis due to primary deposit in the synovial membrane itself, consisting in the gradual destruction of all the structures entering into the formation of the joint, and their replacement by granulation tissue and the subsequent caseation of this tissue. Another situation which may be the primary seat of the deposit of tubercle, in these cases of tuberculous arthritis commencing in bone, is in the end of the bone, just under the articular cartilage. Here also is a quantity of highly vascular embryonic tissue, which is a favourable soil for the growth of the bacillus. When the disease commences in this situation it rapidly perforates the cartilage and infects the synovial membrane.

Symptoms.—The symptoms of tuberculous disease of a joint are usually of a very insidious character in their earlier stage, and the disease may have already existed for some considerable time and have made great advances before serious attention is given to the subject. The child is usually brought to the surgeon with the history that for some time it has been noticed to limp slightly in its gait, if the disease is in one of the joints of the lower extremity, and to complain of pain in one particular joint, especially after a little extra exertion. Possibly also it may be stated that the child has appeared to deteriorate somewhat in its general condition, to have displayed less activity and desire for play, and to become sooner tired after exertion. If the painful joint is examined under these circumstances it will probably be found that there is some slight limitation in the movements of the articulation; a hinge joint, for example, cannot be flexed to the same extent as the corresponding joint on the opposite side of the body without causing pain. There may also be some slight enlargement of the joint, and a little increased heat about it. But in all cases, sooner or later, swelling appears, and this swelling at first corresponds in shape to the synovial sac, and is due to the thickening of the synovial membrane and possibly to a little effusion into the joint. Later on, when the capsule and surrounding structures become implicated, the swelling assumes a globular form, and all the bony prominences are effaced. The swelling is doughy and semi-elastic and presents no discolouration, the skin being white and waxlike in appearance; hence the popular name 'white swelling.' As the disease advances the movements of the joint become more and more limited, and it is semiflexed. When the ligaments have been destroyed partial displacement may take place. Thus in the knee joint the tibia is liable to become displaced backwards and outwards from the action of the hamstring muscles. During the whole of this time there is usually little or no pain whilst the joint is at rest, but more and more pain is complained of after movement and starting of the limb at night sets in. After these symptoms have persisted for a time, the swelling becomes more prominent at one part of the joint, and the skin over it becomes dusky red; softening takes place and eventually fluctuation is perceptible, and finally the skin gives way and discharge of curdy material takes place. The abscess does not necessarily occupy the whole cavity of the joint, but may result from a localised caseation in the granulation tissue. After a time it contracts and forms a sinus which continues discharging. Other localised foci may form in the same way, and thus several discharging sinuses, which may burrow extensively in the tissues around the joint, may form. In many cases retained débris in one of these sinuses undergoes decomposition and a more acute septic process is set up in the remains of the granulation tissue, and this is rapidly destroyed and the whole of the cavity of the joint is converted into a foul abscess, with severe pain and great constitutional disturbance.

The constitutional disturbance in the earlier stages is not great; there may be a little deterioration in the general health, and there is a slight nocturnal rise in the temperature. After caseation has taken place, these symptoms become more pronounced, and the patient's strength deteriorates more rapidly, especially if the starting pains at night are constant, disturbing the patient's rest. When the sinuses are discharging, a general condition of exhaustion and hectic sets in, or a tuberculous condition of some internal organ, as the lungs or the membranes of the brain, may be set up, and may terminate the life of the patient.

When the disease commences in the ends of the bones the symptoms are much the same in the early stage. There is the same history of a slight injury, with pain after exercise and impairment of movement. Before the synovial membrane becomes involved, it may be possible to feel some enlargement of the end of the bone, and on percussing the bone pain may be elicited. Later on, when the synovial membrane becomes infected, the symptoms are identical with those above described, except that after sinuses have formed, on probing them, caseous bone may be felt.

Treatment.—The treatment of the early stage of tuberculous affections of the joints may be summed up in a very few words: rest, with or without extension, and attention to the general health. Rest is the most important factor in the treatment of these affections, and without it all other treatment is useless. It must be borne in mind that this rest, to be of any use, must be absolute and complete, and must be continued for some long period of time. In other words, the joint must be put up in some apparatus that will absolutely prevent any movement in the articulation, and if the joint is in the lower extremity means must be taken to prevent the articular surfaces being pressed upon each other by the weight of the body. Of course this can be done by confining the patient to bed and placing a splint on the limb; but it is very desirable that he should be allowed to get out into the fresh air as much as possible; and the splints invented by Thomas of Liverpool are of esssential service where the hip or the knee is affected. These splints serve to keep the joint immobile, and if a patten is adjusted to the boot of the sound leg, the patient is able to go about on crutches, with the affected limb raised from the ground. When the ankle is affected, an ordinary knee-rest may enable the patient to get about, after the ankle has been placed in a leather or plaster of Paris case, so as to immobilise it. In the upper extremity, all that is necessary is to fix the joint and allow the patient to go about with his arm in a sling. In fixing a limb in this disease it must be borne in mind that a very possible result may be ankylosis, and therefore the limb must be fixed in that position which will be most convenient to the patient should such a condition result. The rest must be continued for a long period. We cannot measure this period by days or weeks, but by months. Twelve months is about the average period that it will take to cure a case of tuberculous arthritis if the disease is fully pronounced when the treatment is commenced, and great care and judgment are required by the surgeon to decide when he may safely allow a little movement. The law laid down by Mr. Howard Marsh in respect to these cases is a good one, that 'rest should be maintained, as a rule, for at least three months after all signs of disease have disappeared.' Care must be taken to commence movements very gradually, and the case carefully watched, so that on the slightest appearance of any recrudescence of the disease the rest may be resumed. Combined with fixation of the joint, extension is often of the very greatest use in overcoming the disease. In these cases the muscles are in a state of reflex contraction, and are the cause of the impairment of movement which we have noticed as one of the symptoms. This tonic contraction of the muscles keeps the diseased articular surfaces closely pressed together, and is a source of a condition of unrest. This may be overcome by extension, which by slightly separating the articular surfaces from each other does away with this undue pressure, and is therefore nothing more or less than a further means of maintaining perfect and absolute rest. In cases of hip-joint disease it is necessary, in order to apply extension, to confine the patient to bed; but in the knee joint extension can be applied whilst the patient is up and about in a Thomas's knee-splint, as will be explained in the sequel. Another use of extension is to overcome any faulty position that the limb may have assumed. As was stated above, a joint affected with tuberculous arthritis is liable to become semiflexed, and it may be fixed in this position by the tonic contraction of the muscles. This faulty position may be overcome by extension exerted in the right direction. Extension is best applied by means of a weight attached to the limb on the distal side of the affected joint and suspended over the end of the bed through a pulley.

In addition to these local measures for the treatment of tuberculous disease of joints, counter irritation by blisters, painting with iodine, mercurial ointment, &c., have been and are frequently recommended, but it is very doubtful whether they do any good, and the disturbance of the parts necessary for their application probably does more harm than the amount of good which is derived from their use. There are, however, two plans of treatment which have been recently advocated which require mention. One of them is the injection of iodoform emulsion, combined with rest and immobilisation. This is injected both into the joint cavity and into the pulpy thickening of the synovial membrane. The injection is often attended by a rise in the temperature and increased swelling, which usually subsides by the fourth day. The emulsion most commonly employed is a 10 per cent. solution in glycerine, to which a certain amount of sterilised water is added (see page 70). Six drachms may be injected into the knee joint of an adult; about half that quantity into the knee joint of a child six or seven years old. The injection may be repeated at the end of a fortnight. The result of this treatment, combined with rest and judicious general treatment, is often very satisfactory, and is especially successful in private practice, where the after-care and open-air treatment can be efficiently carried out. Lannelongue in

1891 introduced the treatment of injecting into the tissues near the tuberculous focus a solution of chloride of zinc (1 in 10). The irritation produced leads to a migration into the tissues of leucocytes, which are supposed to destroy the tuberculous nodules. The injection is performed by means of an hypodermic syringe, and four minims of the solution are injected into different situations in the tuberculous infiltration until half a drachm has been introduced. Care is to be taken that none of the fluid is injected into the cavity of the joint. The cannula of the syringe is to be wiped perfectly dry between each injection, otherwise the skin and tissues along its track will be injured. Under its influence the tuberculous foci are said to be converted into a fibroid material, and hence the name 'Sclerogeny' is given to this procedure. On the whole, it would appear that more favourable results are obtained from the injection of iodoform than from the chloride of zinc. The other method of treating tuberculous joints rests on the high authority of Professor Bier of Kiel, who recommends that a condition of venous engorgement should be induced in the joint, by applying an elastic bandage above and below but not over the joint, or, if it is applied over the joint, only very lightly. This treatment is said to produce rapid subsidence of the swelling and improvement in the condition of the joint.

There is every probability that one or other of these measures may prove useful adjuncts in the treatment of tuberculous affections of the joints; but I think most surgeons will agree that after all our main reliance must be placed in absolute and complete rest in the treatment of these affections.

Whilst local measures are being carried out, the general treatment of the patient must not be neglected. The hygienic surroundings must be rendered as perfect as possible. The child should be kept in the fresh air as much as the weather will permit: residence at the seaside is especially desirable. The diet should be carefully regulated, and the digestive organs attended to. The child should be warmly clad, with woollen clothing next the skin, so as to promote its action, and tonics, especially cod liver oil and iron, administered.

When, in spite of treatment, the disease continues to progress, and chronic suppuration has occurred or is threatening, operative interference will be required. The various operations which may be adopted are arthrotomy, erasion, excision, and amputation.

Arthrotomy consists in laying the joint freely open, washing it out and draining it. In cases where the disease is confined to the soft structures, and the ends of the bones are not much involved, this plan of treatment is often followed by very satisfactory results. If the wound is kept aseptic, a cure with ankylosis may result. The operation consists in freely opening the joint in one or more places in the most dependent position, and in such a manner that no important structures are wounded. The joint is then thoroughly washed out with some antiseptic solution and a drainage tube inserted. The subsequent treatment consists in daily flushing the joint with an antiseptic solution; a solution of tincture of iodine (ʒj to Oj) having proved the most useful in my hands.

Erasion or **arthrectomy** was introduced as a substitute for excision. It consists in laying the joint freely open by an incision planned to expose the whole of the cavity, and removing the diseased tissues without interfering with the healthy parts. In these cases the whole of the diseased synovial membrane is dissected or scraped away as far as possible, and any carious cavities in the bone are scraped, but this structure is not otherwise interfered with. The results which have been obtained have not, as far as my experience goes, been very satisfactory. It is found impossible in many cases to remove the whole of the diseased tissues, and a recurrence frequently takes place; and, moreover, in many cases the ligaments have to be so far interfered with that a very unstable joint is often the result, which in the lower extremity, at all events, is not desirable. In my own practice I have therefore abandoned this operation in the lower extremity, and always remove a thin slice of bone, whether diseased or not, and thus endeavour to obtain bony union; or, in other words, perform excision.

Excision as it is done in the present day consists in performing erasion, and in addition removing the articular surfaces of the bones. The manner in which the operation is performed will be described in dealing with diseases of special joints.

Amputation.—In some instances amputation is the only resource These are cases where there is extensive disease of the bones; for in these, if excision is performed, so much bone has to be removed that a useless limb is the result; moreover, in the young the epiphysial cartilage is involved and future growth of the bone interfered with. Again, if the skin and soft tissues around the joint are extensively involved and riddled, amputation is to be preferred to excision. In determining the question of amputation versus excision the general conditions and the age of the patient have to be considered. When the patient is suffering from hectic, or lardaceous disease of the viscera; or when he is worn out and exhausted by the disease, so that he has very little reparative power to recover from the operation, amputation should be performed. Again, amputation is generally to be preferred to excision in the very young or in those advanced in life. In infants or young children before the age of four or five, if arthrotomy fails to arrest the disease, and the child is evidently sinking from its effects, amputation holds out the best prospect of saving the child's life. And in patients over the age of forty or forty-five excisions rarely do well, and if simpler measures fail to cure the disease, the removal of the limb is, in most cases, called for. Finally, in cases where excision has been performed and failed, and in those cases where acute septic trouble has developed, amputation is the only resource left to the surgeon.

ANKYLOSIS

Ankylosis, or stiffening of joints, is the result of some preceding inflammation of the structures entering into the formation of the articulation. It may be complete or incomplete; that is to say, there may be entire loss of all movement in the joint, or the immobility may be partial.

Complete ankylosis.—In the complete ankylosis of a joint the cause of the loss of motion is the welding together of the bones entering into the formation of the articulation by bone. Hence this form of ankylosis is frequently termed *bony ankylosis.* It may occur in two ways: (1) Where a destructive inflammation has taken place in a joint, and the various structures entering into its formation—the synovial membrane, the cartilages, the articular lamella of the bones, and the ligaments—have been destroyed and replaced by granulation tissue. After a time the process of destruction ceases; and then that portion of the granulation tissue which covers the denuded surfaces of the bones and retains its vitality undergoes developmental processes, and becomes converted into fibrous tissue, and eventually into bone. In this way the two or more bones which entered into the formation of the original joint become firmly united together, as in a compound fracture, and practically form one bone (fig. 195). To this condition the name *synostosis* is applied, because there is a direct growing together of the bones. (2) Another form of bony ankylosis is due to bony bridges or arches being thrown across from one bone to the other around the joint. This is sometimes due to ossification of the ligaments, as is seen in the spine where the anterior common and other ligaments undergo ossification and ankylose the vertebræ together.

Incomplete ankylosis.—In cases of incomplete ankylosis, the stiffness of the joint depends on several different conditions. It is frequently termed *fibrous ankylosis*, for the cause of the stiffening is either the formation of new fibrous tissue, which unites the bones, or the contraction and thickening of pre-existing fibrous tissue.

When it arises from the first of these two causes, it is due to fibrous bands, the result of inflammation, stretching across from one articular surface to the other. These bands may have been caused by a simple synovitis, or by a destruction of the articular cartilage and its repair by fibrous tissue. This form of fibrous ankylosis is the *intra-articular* variety, and when the fibrous bands are very numerous, as often takes place in cases of gonorrhœal synovitis, the union is exceedingly firm and the amount of movement between the two bones comparatively slight. When the stiffening is due to contraction of pre-existing structures it arises from induration and thickening of the capsular ligament the result of inflammation, or from fibrous induration of the soft parts external to the joint, and their contraction, from the limb having been kept long in a fixed and constrained position. This variety is sometimes termed *extra-articular* fibrous ankylosis.

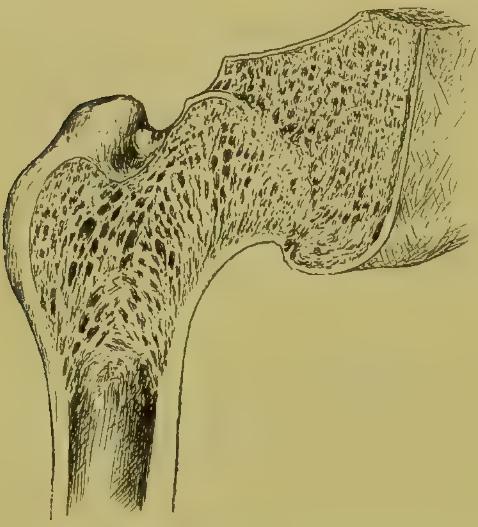


FIG. 195.—Synostosis of the hip. (From the Museum of St. George's Hospital.)

The **diagnosis** between bony and fibrous ankylosis is to be made by the absolute immobility of the one and the greater or less amount of movement permitted in the other. In the firmest degree of fibrous ankylosis, such as we meet with after gonorrhœal synovitis, there is always a certain amount of 'give' or yielding between the articular surfaces, which is most perceptible if the patient is under an anæsthetic, whereas in the bony ankylosis there is none. In addition to this, any attempt at forcible movement, if the ankylosis is fibrous, is attended with pain; whilst the proceeding in bony ankylosis is absolutely painless. The diagnosis between the intra- and extra-articular forms of fibrous ankylosis can be made in the following way. If the ankylosis is intra-articular, except in extreme cases, there is a greater or less degree of movement, which is perfectly free, and then comes to a sudden stop when the bands are put on the stretch; but in the extra-articular form there is no free movement, but a general stiffening of the articulation.

Treatment.—The treatment of ankylosis must depend partly on its nature and partly on the amount of inconvenience it causes. In *bony* ankylosis, if the bones are ankylosed in a position which is most favourable for the use of the limb, they should not be interfered with as a rule. An exception to this may be made in the case of an ankylosed elbow joint, when, on account of the favourable results which attend excision, this operation may be undertaken with the view of substituting a movable for an immovable articulation. If, however, the position of the ankylosed limb is faulty, operative interference, by osteotomy or removal of wedge-shaped pieces of bone, may be undertaken in order to remedy the deformity and increase the comfort and wellbeing of the patient. In *fibrous* ankylosis a great deal will depend upon the amount of stiffness present and the strength of the adhesions. Where they are very strong, and only the slightest amount of motion is obtainable between the two articular surfaces, the case should be treated as one of bony ankylosis; that is to say, if the limb is in a good position, no attempt should be made to break down the adhesions, for if it be done they are almost certain to unite. The amount of injury which is done by the operation is so great that passive motion cannot be applied for some time afterwards, and during this time reunion occurs. If, however, ankylosis is in a faulty position, the patient should be placed under an anæsthetic, the adhesions forcibly broken down by a movement of flexion rather than extension, and the limb restored to a good position. If the adhesions are slighter and there is more freedom of motion, much can be done by constant passive motion, by massage and hot douching, and possibly, in some cases, by forcibly breaking the bands under an anæsthetic. Long patience is required to bring about this result, but with perseverance much may be accomplished by these means.

CYSTS IN AND ABOUT JOINTS

Not infrequently **cysts** form in the neighbourhood of joints, connected with the synovial membrane. One variety of this condition has already been alluded to, where the normal bursæ in the neighbourhood of a joint and communicating with it, as the bursa beneath the semi-membranosus in the ham, become dilated and distended with fluid (page 400). But in addition to these there is another class, where pouches of the synovial membrane protrude through the capsular structures and form cystic swellings, sometimes at a considerable distance from the articulation. These are liable to be mistaken for independent cystic tumours, for the communication with the joint is often so small that pressure on the swelling will not force the fluid back into the joint cavity. The diagnosis of these tumours is not difficult. A soft elastic swelling in the neighbourhood of a joint, of slow growth and without any signs of inflammation, with evidence of some disease in the joint, would sufficiently point to the nature of the case. And in addition to this, in many cases, the tumour will be found to diminish and sometimes entirely disappear on pressure. The treatment is the same as that recommended for bursæ in the neighbourhood of joints (page 401).

LOOSE BODIES IN JOINTS

Loose bodies in joints were formerly known as *loose cartilages.* The name is, however, not a good one, as these bodies may be either cartilaginous, fibro-cartilaginous, bony, or fibrinous. The *cartilaginous* or *fibro-cartilaginous* loose body may originate in two different ways. The most common form is where some of the normal synovial villi or fringes become hypertrophied and subsequently developed into cartilage. Even in the natural condition cartilage cells are frequently to be found in these fringes, so that the cartilaginous body is merely an hypertrophy of the normal condition. The enlarged villi become pedunculated and finally detached, and so constitute 'loose bodies.' These bodies may undergo sometimes a partial ossification, when they constitute one variety of the bony form. A second way in which cartilaginous or fibro-cartilaginous loose bodies may occur in joints is by the chipping off of a portion of the articular or interarticular cartilage from mechanical violence. The most common example of this form is where a portion of one of the semilunar fibro-cartilages of the knee joint becomes detached. The *bony* loose bodies in joints are usually the osteophytic outgrowths occurring at the borders of the bones in cases of osteo-arthritis, which become broken off and remain in the joint as loose bodies. But, in addition to these, cases have been recorded where a portion of the articular surface of a bone has been broken off by mechanical violence and remains loose in the cavity. And, finally, portions of sclerosed bone have been known to separate from the surrounding bone by a process of quiet rarefying ostitis, without suppuration, and to lie loose in the articular cavity. These last two conditions are of exceeding rarity. The *fibrinous* loose bodies may be formed in two ways. They may be the so-called melon-seed bodies, which are composed of a fibrinous exudation from the synovial membrane due to tuberculous disease, and are similar to those found in ganglia (page 397). They are usually of small size, often very numerous, and resemble in shape the seeds of a melon. The other form of fibrinous loose body is the result of extravasation of blood into a joint from injury. The fibrin derived from this is not absorbed, but becomes rounded and moulded by the movements of the joint, and constitutes the loose body. Of all these varieties the common forms are the cartilaginous nodules of the hypertrophied fringes and the osteophytic outgrowth of osteo-arthritis. The joint most frequently affected is the knee, but loose bodies are also occasionally found in the elbow, the shoulder, and the temporo-mandibular joints.

Symptoms.—The symptoms produced by this affection are very characteristic, and consist in a sudden acute pain when the foreign body gets between the ends of the bones in the movements of the joint. Hence it almost always happens that the pain is felt whilst the patient is walking, when the loose body is in the knee joint; during the act of flexing the leg on the thigh the foreign body gets drawn between the articular surfaces, and then, during the act of extension of the leg, is squeezed between the two surfaces, stretching the ligaments and causing the pain. The pain is of a very acute agonising character, producing faintness, and the patient falls to the ground. The joint becomes fixed from muscular contraction, but after the pain has subsided motion returns. The attack is often followed by more or less synovitis, with effusion in the joint. When this subsides, the loose body can generally be felt in the sac of the synovial membrane;

it moves about, and occasionally disappears on examination, and reappears at some future date.

Diagnosis.—The only disease for which these loose bodies are liable to be mistaken is displacement of one of the semilunar fibro-cartilages (see page 521), but a diagnosis can be made by attention to the following points. In the first attack in loose bodies in joints the sudden pain comes on during quiet exercise ; whilst in displacement of one of the fibro-cartilages there is the history of a wrench or twist of the joint. In subsequent attacks, also, the loose body gets between the ends of the bone during flexion and extension of the knee ; in displacement of the cartilage, generally from some twist. The fixation of the knee in the two conditions is also different. When it arises from a loose body it subsides of itself ; whereas when it arises from displacement it requires manipulation or passive movement of the joint to overcome it. In addition to this the loose body can generally be felt either by the surgeon or the patient, who is usually conscious of its presence and can often find it when the surgeon cannot.

Treatment.—There is practically but one way of curing these cases of loose cartilage, and that is by removing them. In former days, when the operation was attended with great risk, palliative measures were adopted, such as fixing the loose body by means of strapping, knee-caps, &c. ; or else attempts were made to fix it by driving pins through it ; or it was removed by subcutaneous section of the synovial membrane and squeezing the foreign body through the opening thus made into the cellular tissue outside the joint. In the present day the open method is universally adopted, the strictest attention being paid to antiseptic details. The loose body is coaxed into some easily accessible place, by preference to the outer or inner side of the patella, and is fixed there by the finger and thumb of the left hand. A vertical incision is now made through the skin and subcutaneous tissues, the capsule, and the synovial membrane, when in all probability the loose body will at once spring out if a little pressure is made with the restraining finger and thumb ; if not, it must be seized and extracted with forceps. The parts are now to be irrigated and the wound closed, care being taken to pick up the synovial membrane on each side with each suture in the manner described when speaking of the operation for displaced semilunar cartilage (page 522). A drainage tube should be inserted for forty-eight hours, and the limb kept perfectly quiet on a splint.

DISEASES OF SPECIAL JOINTS

The shoulder joint.—The shoulder joint is occasionally the seat of simple acute synovitis the result of injury or strain, and also of acute septic synovitis in the course of pyæmia and septicæmia. In addition to this, it is perhaps of all joints the one in which acute arthritis of infants most frequently occurs.

These inflammatory conditions are attended by the ordinary symptoms of inflammation, with effusion into the joint. The swelling is mainly on the outer side, so that the deltoid appears to be expanded and the curvature of the shoulder increased ; this swelling is most marked in front over the bicipital groove ; this is due to the effusion distending the diverticulum, which runs down the groove around the tendon of the biceps. Sometimes a fluctuating swelling may be seen just internal to the lesser tuberosity from effusion into the bursa beneath the subscapularis, which frequently communicates with the joint. In cases of septic synovitis where the joint requires to be incised, it should be opened in front over the most prominent point of the swelling, and a director pushed through the joint and cut down upon behind so as to ensure free drainage.

The shoulder joint is very frequently the seat of osteo-arthritis, and also of Charcot's disease in cases of tabes dorsalis. Less frequently it is the seat of tuberculous disease, the affection beginning in most cases in the head of the humerus; this may lead to destruction of the joint and necessitate excision.

Ankylosis is a not uncommon result of destructive changes in the shoulder joint, and seriously cripples the patient. The ankylosis always takes place with the arm in a dependent position, hanging straight by the side, and it can be only raised from this position by rotating the scapula on the wall of the chest; this seriously impedes the movements of the upper extremity.

If the ankylosis is due to only slight adhesions, a good deal may be accomplished by long-continued massage and passive movements; but these remedial agents are not so satisfactory in this joint as in others, on account of the difficulty in fixing the scapula. In those cases where the adhesions are very firm, or where bony ankylosis has taken place, if the patient is seriously crippled, excision may be resorted to in order to give him a movable joint.

Excision of the shoulder joint may be performed for tuberculous disease and in some cases of acute arthritis, especially in the acute arthritis of infants. It may also, as mentioned above, be performed in cases of rigid ankylosis of the shoulder. For injuries, it may be required in compound comminuted fractures into the joint, especially from gunshot wounds, and in cases of old unreduced dislocations. Possibly it might be called for in cases of simple fracture through the neck of the humerus with displacement of the head of the bone; but these cases are very rare. The patient is placed on his back, with the shoulder projecting slightly beyond the edge of the table. An incision is made from the middle of the acromio-clavicular ligament directly downwards for three or four inches (fig. 196). This incision will divide the skin and superficial structures and the anterior fibres of the deltoid muscle, but will avoid the cephalic vein, which lies a little internal in the groove between the deltoid and the pectoralis major. The incision is directly over the bicipital groove, and this should be felt for with the finger, between the greater and lesser tuberosities of the humerus, and opened along its inner side. The biceps tendon is now exposed, and if it has not been destroyed, should be hooked out of the way. The arm is to be rotated outwards by an assistant; this

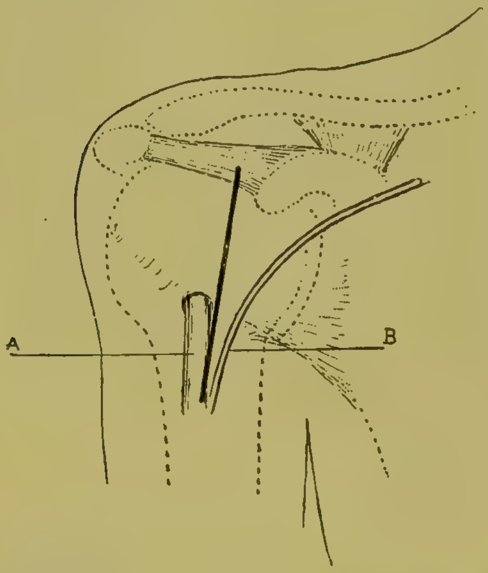


FIG. 196.—Diagram showing the line of incision in excision of the shoulder joint. A, Tendon of the biceps; B, Cephalic vein.

will cause the lesser tuberosity of the humerus to appear at the bottom of the wound, and the surgeon separates the tendon of the sub-scapularis from it, and at the same time divides the capsule of the joint as far inwards as he can reach with his knife. The assistant then rotates the arm inwards, and depresses it; this causes the great tuberosity to appear at the bottom of the wound. The three muscles, supra-spinatus, infra-spinatus, and teres minor, are then severed from their attachments, and the capsule freely divided on the outer side of the joint. The assistant, by still further depressing the arm, forces the head of the bone out of the wound, the surgeon freeing any remains of the capsular ligament behind. The saw is now applied, and the head of the bone cut off. In doing this it is desirable, if possible, to saw parallel to the anatomical neck and a little below it, so as to leave the greater part of the two tuberosities; in some cases, however, where the disease is very extensive, it is necessary to saw through the surgical neck. This, however, is apt to leave a flail-like joint. After the head of the bone has been removed, attention must be directed to the glenoid fossa, and all diseased bone thoroughly gouged away, and all remains of synovial membrane and granulation tissue removed with the flushing gouge. An opening is now to be made at the back of the joint by pushing the point of the knife through the soft parts, taking care to keep well above the posterior circumflex artery, and a drainage tube inserted through the opening. The anterior incision is sutured, the parts dressed, and the arm bandaged to the side, with a large pad in the axilla to prevent the muscles which pass from the wall of the chest to the upper end of the humerus, pulling the bone inwards. Passive motion should be commenced at the end of the first week.

The elbow joint.—The elbow joint is frequently the seat of synovitis, both simple and septic. The simple is the result of injury, strain, or exposure to cold, and is very liable to be followed by permanent stiffening of the joint. The elbow joint is especially liable to become the seat of suppurative synovitis from extension of septic inflammation from neighbouring parts; thus in cases of suppurative inflammation of the bursa over the olecranon, and in cases of diffuse cellulitis of the forearm, which spreads as far as the elbow, this joint is very liable to become involved. When effusion takes place into the joint, the swelling is greatest around the olecranon; that is to say, on its inner and outer sides and above it, so that the hollows in this situation are replaced by a rounded fullness. Occasionally a well-marked triangular fullness may be seen lower down on the outer side of the olecranon, from effusion into the pouch of synovial membrane beneath the anconeus, and the head of the radius is obscured by swelling of the synovial sac in this situation. There is generally merely a little deep-seated fullness at the front of the joint, beneath the brachialis anticus muscle. In cases of suppurative synovitis, incisions should be made into the joint on either side of the olecranon, care being observed on the inner side to avoid wounding the ulnar nerve. In cases of synovitis, care should be taken to maintain the limb in such a position as to give the patient a useful member in case ankylosis ensues. This should be a *little less* than a right angle, so as to enable the patient to get his hand to the back of his head or to his mouth. The difference between a right angle and a slightly acute angle is of great importance as regards the comfort of the patient. In cases of fibrous ankylosis of the elbow joint, the treatment by massage and passive motion is not always very satisfactory, on account of the complicated nature of the joint; and the treatment by forcible rupture is still less so, the adhesions almost always re-forming. Should the ankylosis be at all firm, or should it be bony, the operation of excision should be seriously considered, and this more especially if the ankylosis has taken place in not quite the most satisfactory position. The results of this operation are most excellent, a joint being formed in which there is a very great range of movement and almost as much strength as in the natural one. Tuberculous arthritis is of common occurrence in the elbow joint; in these cases the forearm becomes semiflexed, the position of greatest ease and relaxation of ligaments. It must be borne in mind that the superior radio-ulnar joint forms part of the elbow joint, so that the power of supination and pronation is interfered with or lost. The disease in these cases may begin either in the synovial membrane or the bone. Loose bodies are very rarely met with in the elbow joint, and they do not, as a rule, give rise to the same urgent symptoms as they do in the knee. The elbow joint is occasionally the seat of osteo-arthritis, but not so frequently as some of the other larger articulations.

Excision of the elbow joint may be required for tuberculous disease, severe injuries of the joint, and ankylosis. It is also occasionally called for in cases of disorganising arthritis, in old unreduced dislocations, and in osteo-arthritis. There are several ways of performing the operation; by H- or T-shaped incisions, or by a single vertical incision down the back of the joint. This latter is probably the best, and is the one most generally employed, and will be the one described here. It can easily be converted into a T-shaped incision by making a transverse cut across the external condyle, if from thickening and fixation of the parts there is not room enough for the necessary manipulations. The forearm is flexed to a right angle and held across the chest of the patient by an assistant, and a vertical incision is made over the back of the joint, some four or five inches in length, according to the amount of thickening of the tissues, so that the centre of it lies a line or two to the inner side of the top of the olecranon (fig. 197). This incision is made directly down to the bone, in its upper part dividing the tendon of the triceps longitudinally. The tendon is then separated from the upper surface of the olecranon, and this process cleared on its inner and outer surfaces. In clearing the olecranon great care should be taken to keep close to the bone, so as to avoid wounding the ulnar nerve on the inner side, and the prolongation of the triceps into the deep fascia of the forearm on the outer side. It will now much facilitate proceedings if the olecranon is cut through with a pair of cutting bone forceps and removed, though many surgeons leave this to a future stage of the operation. The olecranon having been removed, the surgeon, introducing his thumb into the wound and keeping his nail close to the bone so as to protect the soft parts, gradually separates the structures from the internal condyle with the point of his knife or with a periosteal elevator; in this way he detaches the common tendon of origin

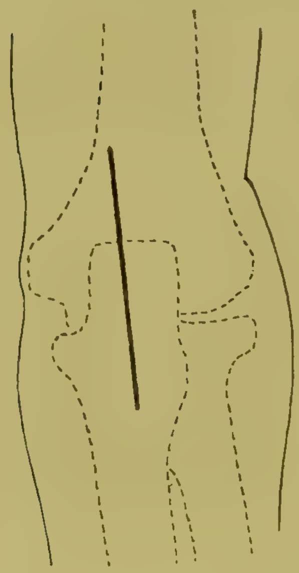


FIG. 197.—Diagram showing the line of incision in excision of the elbow joint.

attached to the internal condyle, and divides the internal lateral ligament. During this proceeding the ulnar nerve will probably not be seen, as it is embedded in the inflamed tissues around, but its presence must be constantly in the mind of the operator, and he must keep close to the bone. When the internal condyle has been freed, the same proceeding is gone through with regard to the external condyle. The end of the humerus is now protruded through the wound by flexing the forearm until it touches the arm, and the articular surface is separated with a saw. No more than the articular surface should be removed, and the shaft of the bone should not be encroached upon. If any carious cavities exist on the sawn surface, it is better to scrape them out rather than remove more bone. The bones of the forearm are now forced out through the wound, cleared from surrounding structures, and the cartilage-covered surfaces sawn off. Here also the section of the bones must not be carried too low so as to interfere with the insertions of the brachialis anticus and biceps. After the articular surfaces have been removed, the whole of the pulpy synovial membrane and granulation tissue must be dissected or scraped away; any sinuses which may exist must be thoroughly scraped, and the parts well douched with an antiseptic solution. A drainage tube is inserted in the most dependent position, and the wound sutured and dressed. No splint is necessary, and the most comfortable position for the patient is the extended one, the arm being laid on a pillow and supported on either side by a sandbag. At the end of the second day the drainage tube should be removed, and the forearm may now be flexed on the arm. Each succeeding day the position should be altered, and at the end of ten days, if all goes well, the wound will probably be healed and passive motion may be commenced. The object of the operation is to obtain a strong false joint, with movement in every direction; the passive motions must therefore be systematically and thoroughly carried out, and the forearm not only flexed and extended, but also pronated and supinated. If the operation is carried out on the lines indicated above and too much bone is not removed, there is no danger of undue mobility; but sometimes in cases of extensive injury, where a large amount of bone has to be removed, a flail-like joint results. The patient may be allowed to get up at the end of the second week and go about carrying his arm in a splint.

The wrist joint.—The wrist joint is not often the seat of simple synovitis from traumatism, on account of the great mobility of the hand allowing it to escape the effects of any severe injury. But it is not infrequently the seat of rheumatic and gonorrhœal synovitis and also of septic synovitis in cases of pyæmia. In cases of suppurative synovitis the disease is of special importance, because the inflammation tends to spread to the carpal joints and cause their destruction.

When the synovial sac is distended with fluid, there is general fullness both on the palmar and dorsal surfaces of the wrist, but especially the latter. The swelling bulges upwards between the tendons and partially displaces them. In cases of suppurative arthritis, incisions must be made parallel to the tendons and without opening their sheaths. Chronic inflammation of the wrist is generally tuberculous, the disease in most cases commencing in the synovial membrane. It is more common in the adult than in children, and is particularly liable to occur in senile tuberculosis. It often leads to infection of the synovial sheaths of neighbouring tendons, or extends to the synovial sacs of the carpal joints and leads to destruction of the carpal bones.

Excision of the wrist joint.—The only cases in which excision of the wrist is required are cases of tuberculous disease. This is to be done by the method introduced by Lord Lister, which is planned so as to avoid injuring any of the tendons going to the fingers and thumb, and divide only those which belong to the wrist proper. The first step in the operation consists in moving the fingers and thumb freely, so as to break down any adhesions. An incision is then made from the middle of the dorsal surface of the radius, on a level with the base of the styloid process, downwards and outwards, parallel and internal to the tendon of the extensor longus pollicis, as far as the radial side of the base of the second metacarpal bone, close to the insertion of the extensor carpi radialis longior, and is then carried straight onwards along the radial border of the posterior surface of this bone for half its length (fig. 198). In this incision the extensor carpi radialis brevior is divided, and the extensor carpi radialis longior, which is exposed, is now to be severed close to its attachment to the metacarpal bone (fig. 199). By extending the wrist and cutting between the tendons and the bone, the extensor tendons are to be separated from the back of the wrist as far as possible towards the ulnar side, and the extensor tendons of the thumb and the radial artery separated on the outer side of the incision. A pair of cutting pliers are now to be introduced into the wound, and the trapezium separated from the other bones of the carpus. The hand is then turned over so that the palm is uppermost, and an incision made on the ulnar side, commencing two inches above its lower extremity, and carried along its anterior border across the wrist and as far as the middle of the fifth metacarpal bone on its palmar aspect. By deepening this incision the knife is carried between the flexor carpi ulnaris and the bone, then through the articulation of the pisiform to the cuneiform till it meets the unciform process of the unciform bone, which is to be cut off with bone forceps. The tendons and soft parts are now to be completely separated from the bones, and the extensor carpi ulnaris divided as close to its attachment as possible. The dorsal and internal lateral ligaments are also to be cut. By flexing the hand at the wrist, the soft parts are now to be separated from the bones by carrying the knife horizontally between them. In doing this the knife must be kept close to the bone for fear of wounding the ulnar artery and nerve, and the separation must not be carried beyond the bases of the metacarpal bones, to avoid the deep palmar arch. After now dividing the anterior ligament of the wrist, the carpus will be freed from the radius above, and by introducing the bone forceps and cutting across the line of articulation of the carpus and metacarpus, it can be extracted with a pair of sequestrum forceps, any slight attachments remaining being touched with the point of the knife.

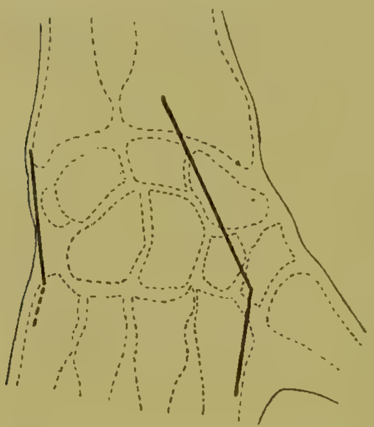


FIG. 198.—Diagram showing the lines of incision in Lister's excision of the wrist.

The trapezium, the pisiform, and the unciform process still remain; the two latter are to be left, unless the pisiform is so diseased as to necessitate its removal, but the trapezium is to be removed, great care being taken in dissecting it out to keep quite close to the bone, for fear of wounding the radial artery. The ends of the radius and ulna can now easily be protruded from the wound and the articular surfaces sawn off: in doing this the styloid process of the ulna should be left if possible, as it prevents displacement of the hand to the ulnar side, which is otherwise liable to take place. The metacarpal bones are now protruded through the wound—the fourth and fifth through the ulnar wound, and the second and third through the radial—and a thin slice taken off their bases. The base of the first metacarpal bone is removed with cutting forceps, as is also the articular surface of the pisiform, if the whole bone does not require removal. The radial incision is entirely closed, and a drainage tube inserted into the middle of the ulnar incision, the rest of it being closed. The great object in the after treatment is to get a firm wrist and movable fingers. The arm and hand are to be put upon a straight splint to which a piece of thick cork has been attached, so that the wrist shall be slightly extended and the hand semiflexed. A second lateral projection of cork is fixed to the splint, on which the thumb rests. The fingers must be thoroughly flexed and extended at both phalangeal and metacarpo-phalangeal joints every day, commencing the second day after the operation; while the wrist must be kept immovably fixed on the splint for a long period of time, as there is danger of a flail-like joint on account of the amount of bone removed; and even after the splint has been removed some support to the wrist will be required for months.

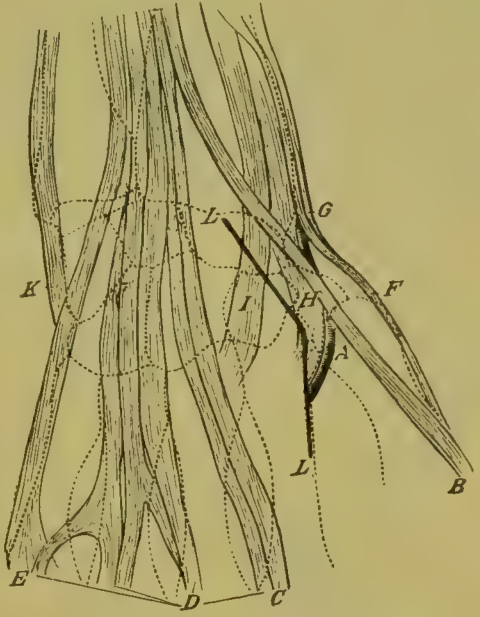


FIG. 199.—Diagram of excision of the wrist, after Lister. A, radial artery; B, tendon of the extensor longus pollicis; C, ext. indicis; D, ext. com. digitorum; E, ext. min. dig.; F, ext. brev. pol.; G, ext. oss. met. pol.; H, ext. carp. rad. long.; I, ext. carp. rad. brev.; K, ext. carp. uln.; L, L, line of incision. (From 'A System of Surgery,' by Holmes and Hulke.)

The hip joint.—Simple acute synovitis is not of so common occurrence as a similar condition in many other articulations, on account of the depth of the joint and the protection which is afforded to it by surrounding muscles. When it does occur, it is attended by the ordinary symptoms, the swelling being due to effusion into the synovial membrane. The swelling is not very great, and is principally situated at the front and back of the joint. That in front shows itself as a little fulness in the upper part of Scarpa's triangle, so that the fold of the groin is not so marked as on the other side of the body, and the femoral artery can be felt to be beating superficially, being raised by the effusion beneath. The superficial inguinal glands may also be noticed to stand out prominently under the skin as little almond-shaped bodies, especially if they are at all enlarged. The swelling behind is merely a little fulness in the gluteal region, which is not easy to detect by digital examination. The most characteristic symptom of effusion is the position of the limb, which is flexed, abducted, and rotated outwards, and more or less fixed in this position. Several reasons have been assigned for this. It is probably due to the same cause which produces change of position—generally semiflexion—in other joints under similar conditions, namely, that it produces the greatest relaxation of the ligaments, and therefore the greatest ease. Acute septic synovitis of the hip is not uncommon in pyæmic cases, and also in acute epiphysitis of the upper end of the femur, because the epiphysial cartilage is situated in the joint. In these cases free incision as early as possible is required, for displacement is liable to occur, or the head of the bone become rapidly separated from the shaft by the destructive process going on in the neighbourhood of the epiphysial cartilage, if active measures are not at once resorted to. In dealing with these cases an anterior incision should be made as if for excision of the hip, so that the joint can be thoroughly explored with the finger, and then a counter opening should be made behind for efficient drainage.

Destructive disease of the hip, either from septic causes or in tuberculous affections, may lead to ankylosis, and this ankylosis may be fibrous or bony, and may take place either in a good or faulty position. When the ankylosis is in a good position, nothing much requires to be done, unless it is slight and due to peri-articular effusion, when the functions of the joint may be restored by well-regulated movements and massage; but if the adhesions are old, firm, and especially if they are intra-articular, probably very little benefit will be obtained from these measures; and if the patient is anæsthetised and the adhesions forcibly broken down they will in all probability form again; as there is some risk of disaster in performing this operation, it is better to leave the patient alone, especially as an ankylosed hip in a good position is not accompanied by a very considerable degree of lameness. But when ankylosis has taken place in a faulty position (fig. 200), the condition must be remedied, otherwise grave deformity will be the result. The position in which faulty ankylosis of the hip generally takes place is that of flexion, with or without adduction of the limb. If the hip joint is fixed in a position of flexion, the patient must tilt the pelvis forwards, in order to bring the limb to the ground, and then, to preserve the equilibrium of the body, great lordosis or incurving of the spine in the lumbar region takes place. And, again, if the thigh is fixed in a position of adduction, in order to produce parallelism of the two limbs, the pelvis on the affected side has to be tilted upwards. This throws the spine out of the proper axis of the body, and in order to

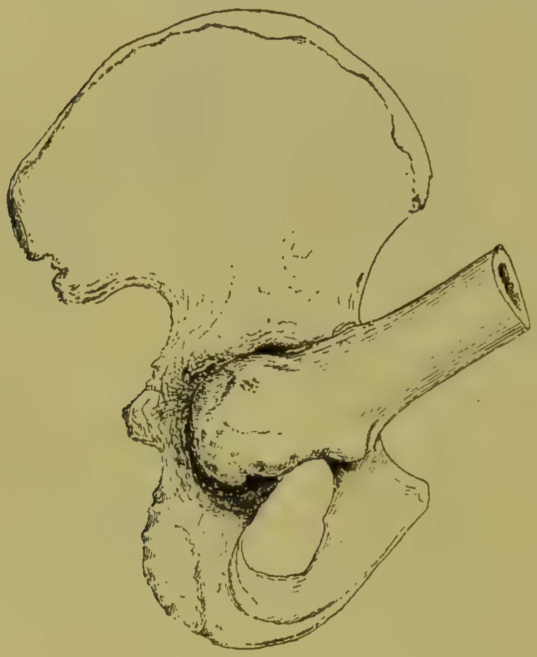


FIG. 200.—Synostosis of the hip joint in an extremely faulty position. (From the Museum of St. George's Hospital.)

preserve its equilibrium it has to be bent over to the affected side, and so a condition of lateral curvature is the result. Thus it follows that in a case of faulty ankylosis of the hip in a position of flexion and adduction the gravest deformity is set up. The same would be the result of ankylosis in a position of abduction, except that the spine would be bent in the opposite direction. If the ankylosis is fibrous, an attempt should be made to rectify the position without operation, and when the ankylosis is recent and not very firm, this can often be accomplished by extension. The patient is laid on a hard flat bed with the foot of the bed raised so as to make counter extension, and a weight, running over a pulley and hanging over the end of the bed, is attached to the thigh by a stirrup. The weight should be about 14 lbs. for an adult. If this does not succeed an attempt may be made, under an anæsthetic, to break the adhesions and get the limb into good position. If one of these measures succeeds, and the thigh can be brought down to the extended position and parallel with the other limb, or even into a position of slight abduction—which is not disadvantageous, especially in the female—it should be put up in a plaster of Paris casing or some other fixed apparatus until consolidation takes place. If, on the other hand, the faulty position cannot be overcome by these means, operative interference must be resorted to. There are two ways of doing this. Sayre attempted, by sawing out a semicircular piece of bone above the lesser trochanter, to obtain a movable joint; but a fixed position of the limb is preferable in these cases, and the result of the operation is very uncertain, and therefore it need not be further alluded to. The usual operation consists in subcutaneously dividing the femur and putting the limb up in a good position, and keeping it there until osseous union has taken place. The femur may be divided through the neck (Adams's operation) or below the trochanters (Gant's). Adams's operation is applicable only to those cases where there has not been extensive destruction of the head of the bone. It consists in introducing a long and strong tenotome, with a cutting surface of about an inch at its extremity, midway between the anterior superior spinous process of the ilium and the top of the great trochanter, and carrying it downwards and inwards until its cutting edge reaches the front of the neck of the femur, when it is made to divide the capsule and tissues in front of the bone. The knife having been withdrawn, an Adams's saw (fig. 201) is introduced and passed down to the neck of the bone and it is sawn through. In doing this the saw must always be maintained parallel to Poupart's ligament, so that the neck may be sawn at right angles to its axis. After the bone is divided the wound is closed and the limb brought down straight and fixed in this position. A Bryant's double long splint will be found to be the most efficient way of doing this, for

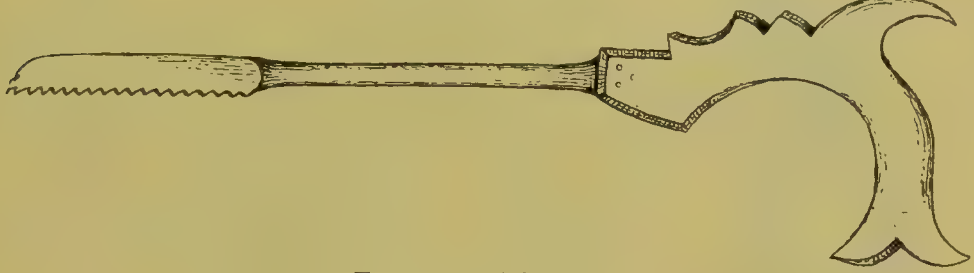


FIG. 201.—Adams's saw.

extension can be made by means of an accumulator so as to maintain the proper length of the limb. Gant's operation must be performed in those cases where there has been considerable destruction of bone, so that the neck is stunted and has practically disappeared; or when it is much thickened by the formation of new bone between the trochanter and ilium. A narrow-bladed scalpel is introduced on the outer surface of the femur just below the great trochanter, and is carried downwards to the extent of about an inch, severing all the structures to the bone. The bone is divided with an osteotome, or saw, and put up in the straight position.

Occasionally cases of ankylosis of both hips are met with, producing the condition of cross- or scissor-legged deformity (fig. 202). The limbs, under these circumstances, are strongly rotated outwards. The treatment is the same as for ankylosis of one hip.

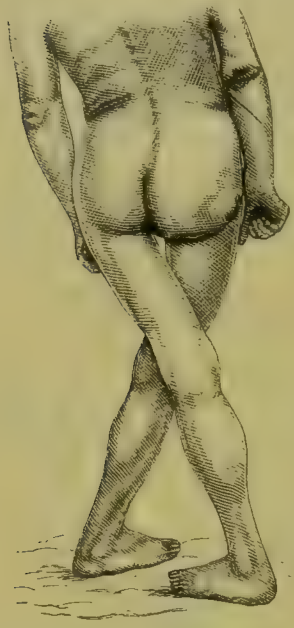


FIG. 202.—Scissor-legged deformity. (From Erichsen's 'Surgery.')

Osteo-arthritis is of common occurrence in the hip joint, and is said to be more frequently met with in the male than in the female. There is nothing peculiar about the condition, as it occurs in the hip, to require separate consideration.

Tuberculous disease of the hip is constantly met with, especially among the children of the poor.

Pathology.—The disease may begin either in the bone or the synovial membrane, but it would seem probable that the disease begins much more frequently in the former than in the latter situation. When it commences in the bone, the part first attacked, in the majority of cases, is the growing tissue at the end of the shaft in the neighbourhood of the epiphysial cartilage, but in some instances it would appear to commence in the growing bone in the centre of the epiphysis; and, again, in other cases it begins in the acetabulum in the embryonic tissue in the neighbourhood of the Y-shaped cartilage.

When the disease commences in the neck of the bone, in the neighbourhood of the epiphysial cartilage, the joint speedily becomes implicated; for this cartilage lies within the capsule, and the morbid process spreads along its under surface and rapidly invades the joint, and the synovial membrane becomes secondarily involved, and pulpy degeneration is set up.

In some few cases, however, the joint does not become so seriously affected. The tuberculous deposit on the under surface of the epiphysial cartilage slowly caseates and forms a chronic abscess in the end of the shaft. This gradually increases and approaches the anterior surface of the neck of the bone; but before it perforates it, adhesion of the two surfaces of the synovial membrane—that covering the neck of the bone and that lining the capsule—takes place, and the abscess finds its way through these two layers without implicating the joint generally. It may then point externally, and when opened the abscess will be found to extend into a carious cavity in the neck of the bone without involving the joint. These cases are, however, very rare, and in the majority speedy implication of the joint follows the deposit of tubercle in the neck of the bone. In many cases, if the morbid process, starting at or near the centre of the bone, spreads evenly in every direction, the head may be completely separated from the neck, and, lying loose in the cavity, may form a sequestrum. When the disease begins in the acetabulum, and also in those cases where the acetabulum becomes secondarily affected from disease commencing in other parts, perforation may take place, with the result that abscess is formed within the bony pelvic cavity. The caseous material is, however, prevented from getting into the true pelvis by the pelvic fascia, which becomes thickened. It usually tracks upwards and bursts in the groin just above the level of Poupart's ligament. As the disease progresses and involves all the tissues of the joint, the constant pressure of the head of the bone against the upper and posterior part of the acetabular margin causes absorption of it, and the bone is drawn slowly upwards and backwards and is in this way displaced from its natural position. As the acetabular cavity in this way becomes enlarged, a new rim of bone is developed around the head of the bone, forming, as it were, a new margin to the acetabulum. This condition is sometimes spoken of as a 'wandering acetabulum,' since the new rim, after its formation, is gradually absorbed and a fresh rim deposited beyond. The consequent alteration in the position of the head of the bone is frequently called dislocation, but it is not a true dislocation, for the head of the bone does not leave the acetabular cavity. The condition is one rather of enlargement of this cavity, and an alteration of the position of the bone in consequence thereof.

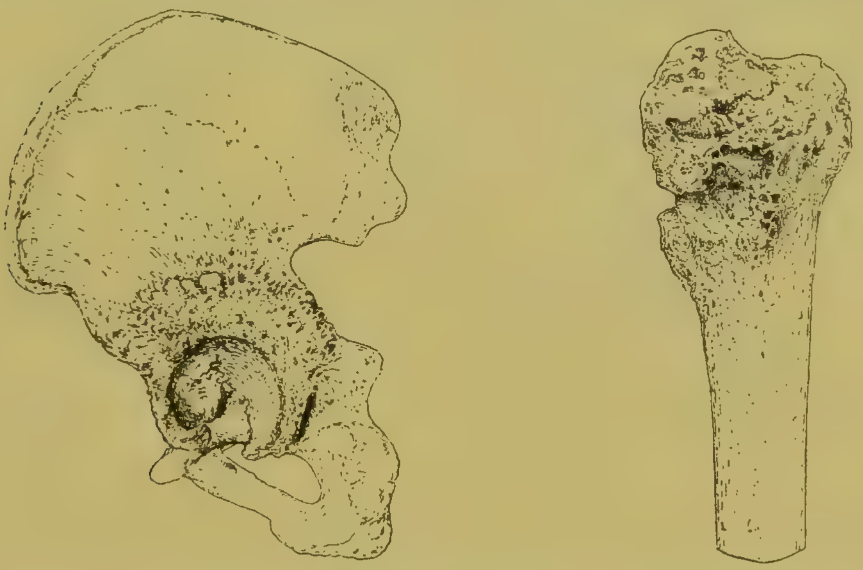


FIG. 203.—Advanced disease of the hip joint, showing the changes in the bones which have taken place. (From the Museum of St. George's Hospital.)

As the disease advances and all the structures of the joint are involved, the cartilages and ligaments become destroyed, the head of the femur and the acetabulum carious, and the remains of the joint filled with curdy pus (fig. 203). The abscess usually perforates the capsule behind, and then tracks forwards beneath the gluteus minimus to its anterior border, and passing beneath the tensor vaginæ femoris, appears as a fluctuating swelling on the upper and outer part of the thigh, a little below the anterior superior spinous process of the ilium.

Symptoms.—The signs of hip-joint disease are, in the early stage, often very insidious, and as it is all-important that the disease should be recognised at the earliest possible moment, great attention should be paid to these early symptoms; for it is in these cases only, before the disease has gone on to destruction of tissue, that a successful result from treatment, with perfect restoration of the movements of the joint, can be looked for. The child is generally brought to the surgeon with the history that for some time it has been ailing, fretful, disinclined to play or take any exertion, and has perhaps been capricious with regard to its food. One will be told perhaps that the child will play about for a time and then stop, saying that he is tired or has a pain in the knee or the hip, generally the former; that he has constantly been noticed to limp, but that this has been merely regarded as a bad habit. With such a history, the patient should be carefully examined. He should be stripped and laid on a table or hard level couch on his back. The lower limbs should be laid side by side flat on the table, and the length of the two compared. If there is hip-joint disease, the affected limb may be apparently longer than the sound one; that is to say, the foot will project beyond the other one. This is due to the thigh being abducted, and, therefore, in order to produce parallelism of the two limbs, the pelvis is tilted downwards on the affected side (fig. 204). A straight rod should now be placed over the lower part of the abdomen, touching the two anterior spines of the ilium; if this tilting of the pelvis has taken place, the rod will be oblique to the long axis of the body. By now gently abducting the thigh, the pelvis will be noticed to right itself, and eventually the two anterior spines will be on the same level; the position the limb is now in will give the amount of abduction that is present. The hand should next be placed under the patient's back in the lumbar region, and it should be noted whether the lumbar spines are raised from the table—whether, in fact, there is a condition of lordosis. If there is, it will denote that the thigh is flexed on the pelvis (fig. 205). By gently raising the limb from the table the lordosis will become lost, and when the hollow has quite disappeared the position of the limb will show the amount of flexion present. Attention should now be directed to the movements of the joint. The patient, lying

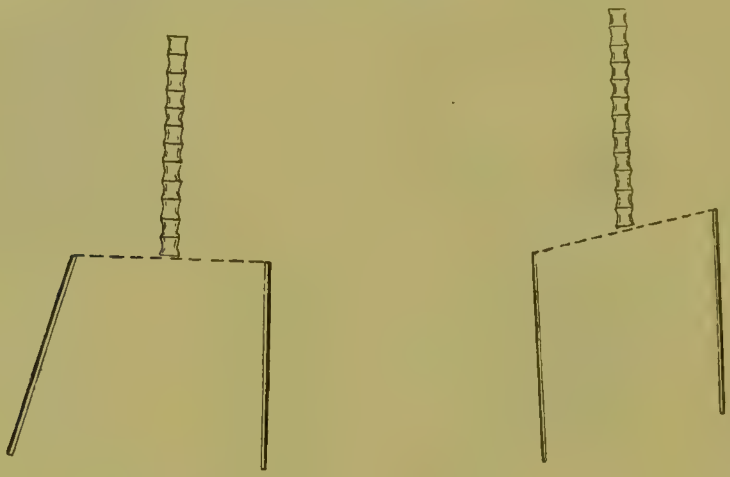


FIG. 204.—Diagram showing the tilting of the pelvis in abduction of the femur in hip-joint disease.

on his back, should be directed to draw the limb up as far as he can; if the disease has proceeded far enough to produce complete rigidity, no movement will take place in the hip joint, but the anterior spine of the ilium, if the finger is placed upon it, will be felt to recede, the limb being raised by a rotation of the pelvis. If the disease has not advanced so far as to produce complete rigidity, the movements of the hip joint will be found to be limited; the patient will not be able to flex the thigh as acutely on the abdomen as on the sound side, and if the surgeon seizes the affected limb and abducts it, it will be found that abduction cannot be carried so far as it can be on the other side. This limitation of movement is due to reflex muscular spasm, the irritation in the joint causing a reflex contraction in the muscles around it, and so more or less fixing the joint. This impaired power of movement constitutes the most important and the most valuable sign of hip-joint disease; for in many cases which come under the notice of the surgeon there is not absolute fixation of the joint, and it is not till this has taken place, with the limb in a position of abduction and flexion, that the inequality in the length of the limbs and the lordosis is present. But the stiff, painful and impaired mobility is observable from the first, and when present should always put the surgeon on his guard. In addition to the flexion and abduction of the thigh, it will be generally noted to be somewhat everted or rotated outwards; so that the position of the limb in the early stage of hip-joint disease is one of abduction, flexion, and external rotation. The surgeon may also sometimes notice in these cases a certain amount of fulness in front of the joint, especially in those cases where the disease has commenced in the synovial membrane, and where there is some effusion within the capsule of the joint. This fulness is indicated by a partial or complete obliteration of the fold of the groin, and often by a prominence of the superficial inguinal glands, which are sometimes enlarged and stand out prominently under the skin. Another constant and important sign is flattening of the buttock. If the patient is turned over on to his face, the buttock on the affected side will not present the same rounded outline as

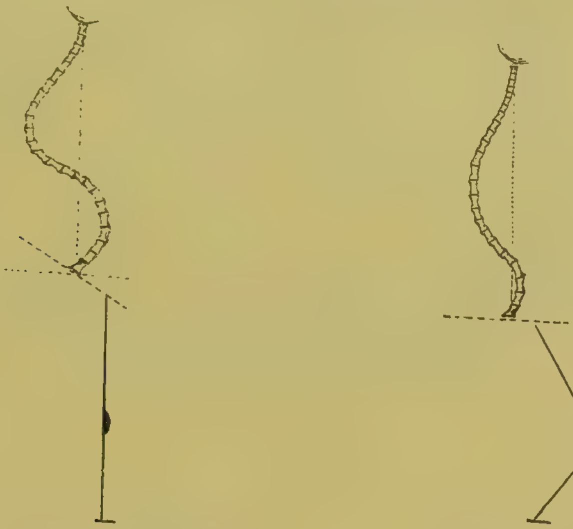


FIG. 205.—Diagram showing the tilting of the pelvis in flexion of the femur in hip-joint disease.

that on the opposite side, but will look flattened and depressed, and the gluteal fold at the back of the thigh will be wholly or partially obliterated. This is in a great measure due to wasting of the gluteal muscles, but no doubt also to a certain extent to the flexed position of the limb. The other muscles of the limb are also wasted, and this wasting is manifest at a very early period of the disease, within a few weeks after its commencement. The amount of pain in tuberculous disease of the hip varies: in the greater number the pain is either very slight or there is none at all, except after using the limb; in others the disease sets in with pain, sometimes of an acute character. The pain is often referred to the knee, that is, to the peripheral termination of the obturator nerve, which supplies both joints.

As the disease progresses the pain increases, and the patient complains whenever the joint is moved. Starting pains occur at night, and the wasting of the limb becomes more marked. The position of the limb is altered; while the flexion still remains, the limb becomes adducted and turned inwards, so that the direction of the axis of the femur is across the sound thigh. When this condition of things comes about, the patient instinctively, if left alone, lies on his sound side, with the affected limb thrown across its fellow, and the knee resting upon the bed beyond it. The cause of this change in position is not very clear, but it is usually said to be due to the action of the adductors and internal rotators overcoming the resistance of the external rotators and the posterior part of the capsule, which have been weakened by the inflammatory changes which have taken place in them. In consequence of this change from abduction to adduction, the pelvis is now tilted upwards, and there is apparent shortening of the limb when the thighs are parallel. During this stage of the disease there is a certain amount of constitutional disturbance: the temperature is slightly above normal in the evening, and there is loss of flesh and general deterioration in the condition of the child. After a time some increased fulness in the region of the joint indicates that matter is forming, and soon deep-seated fluctuation will be felt, in most cases on the outer side of the upper part of the thigh, beneath the anterior superior spine; sometimes it may be more internal, underneath the pectineus; or in the back, beneath the glutei muscles. In cases where the disease begins in the acetabulum, the matter, as stated before, usually comes to the surface above Poupart's ligament to the inner side of the femoral vessels; though in rare cases it burrows downwards, and points in the ischio-rectal fossa.

After suppuration sets in, the final stage of the disease occurs. This is the stage of real shortening, and the shortening is due to two causes: to the gradual enlargement of the acetabulum and the shifting upwards of the head of the bone, and to erosion of the upper end of the femur. In those cases where the disease begins in the upper end of the shaft, and the head becomes separated from this part of the bone, the shortening is often very great.

After the abscesses point and burst through the skin, they leave sinuses, which burrow in every direction and discharge for an indefinite period. The patient steadily wastes, and eventually dies of lardaceous disease in the majority of cases, unless previously carried off by some other tuberculous condition. Occasionally, however, he may live through it; the sinuses may close and the patient recover, with an ankylosed hip and serious deformity.

Diagnosis.—There are many other affections for which disease of the hip joint has been mistaken, such as angular curvature of the spine, accompanied by psoas or iliac abscess; sacro-iliac disease; coxa vara; abscess in the neighbourhood of the joint without implicating it; lordosis due to acute rickets; congenital dislocation of the hip, and affections of the knee, on account of the pain being referred to this articulation. But careful attention to the various symptoms enumerated above ought generally to be sufficient to establish a diagnosis. The main point to pay attention to is the limitation of movement. If the limb can be as freely flexed, abducted, and everted as the one on the opposite side, there is probably no disease in the joint; but if it is found that the thigh cannot be as completely flexed and rotated as the one on the opposite side without causing pain, especially if there is slight apparent lengthening, or muscular wasting, or lameness, then the diagnosis of hip-joint disease may be confidently made. Perhaps sacro-iliac disease is that condition from which it is most difficult to distinguish it, especially in those cases where the disease has commenced in the acetabulum. But it will be found that in sacro-iliac disease, if the pelvis is fixed by the hand of the surgeon, the hip joint can be moved in every direction without causing pain; while pressure upon the crests of the ilia causes pain by pressing the inflamed surfaces of the joint together. Of course, in the later stage of hip-joint disease, after real shortening has taken place, the diagnosis is easy.

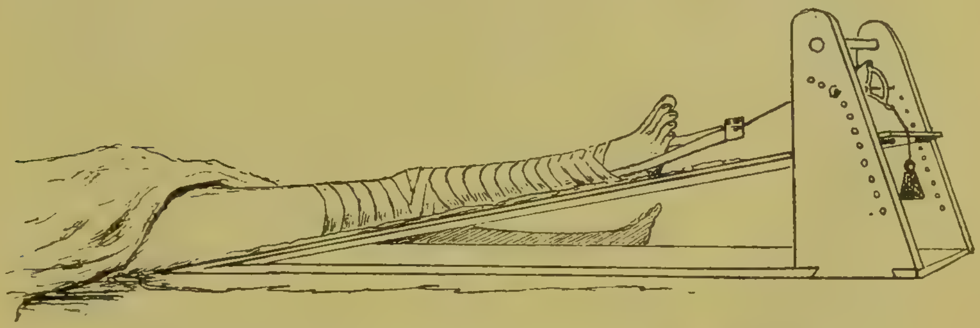


FIG. 206.—Muir's inclined plane, for making extension in hip-joint disease.

Treatment.—The treatment of early hip-joint disease consists in absolute rest and the removal of any abnormal position which may exist. And if the treatment is commenced in quite the early period of the case, and is continued for a sufficiently long time, the prognosis is decidedly favourable; a large proportion of cases recovering without the formation of an abscess, and with a movable joint. This is especially so when the disease occurs in children. The two points in the treatment—rest and correction of deformity—are best attained by the weight and pulley. The patient is placed in bed, on a firm hard mattress, and a stirrup is applied to the limb, so that its ends extend halfway up the thigh, and thus prevent any traction on the ligaments of the knee joint. To this stirrup is attached a weight by means of a cord which runs over a pulley fixed to the end of the bed. The weight need not necessarily be a very heavy one, as its constant action soon overcomes the resistance of the muscles—one of four or five pounds is generally sufficient for children of the age of eight to ten.

In applying this apparatus it must be placed in the position which the limb has assumed in consequence of the disease. If the limb, as is generally the case, is in a position of flexion and abduction, it must be raised from the bed till all lordosis has disappeared, and must then be abducted until the two anterior superior spines are level, and extension must be made with the limb in this position. When this has been done, the lower extremity is generally supported in this attitude by pillows; but I am in the habit of using a light framework which was invented by a former House Surgeon at the Victoria Hospital for Children—Dr. Muir—which answers its purpose admirably (fig. 206). It consists of an inclined plane fixed on a light framework in such a manner that it can be adjusted at any angle. To the framework is also attached the pulley, over which extension is made, and this can be fixed at any level. As the flexion of the limb subsides, the inclined plane can be lowered gradually and steadily until the limb is in the same plane as the body.

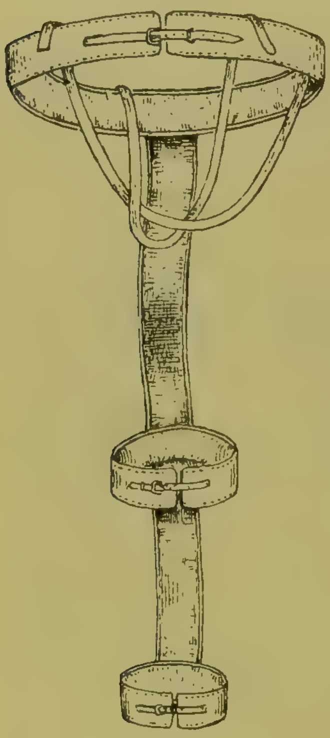


FIG. 207.
Thomas's hip splint.

When extension is not made in the true axis of the thigh, it tends rather to increase than diminish the amount of intra-articular pressure and to produce a greater amount of lordosis. As the flexion is corrected the inclined plane is lowered, so that the extension may still act in the long axis of the thigh, until at last the limb is brought into the same line with the body. If there is any difficulty in keeping the patient, when a child, on its back in the horizontal position, a long splint may be applied to the opposite side of the body. The time which is required to bring the limb down straight is generally less than a fortnight, and when this end has been accomplished, one of two methods may be adopted, the *sine qua non* of both being the maintenance of absolute rest to the joint. By far the best plan is to keep the patient in bed, with the weight extension still applied, for several months. If the patient belongs to the more wealthy class, and his surroundings are such that he will not suffer from the long-continued confinement to bed, this plan should be adopted. But in hospital cases among the poor this cannot be carried out. The patient cannot be kept in hospital, and if allowed to go home the enforced quietude will in all probability not be maintained, and therefore the second alternative has to be adopted. This consists in applying an immovable apparatus to fix the joint and allow the patient to go about on crutches, with a patten on the sound foot, so that the affected limb cannot reach the ground, and by its weight makes a certain amount of extension when the patient is in the erect position. The best apparatus that we possess for fixing the joint is Thomas's splint (fig. 207). This consists of a flat bar of malleable metal, which is moulded to fit the various curvatures of the back, and extends from the level of the axilla to just above the ankle. To this three pairs of curved bars are attached. The uppermost pair embrace the chest on a level with the nipple, and the two ends are buckled together by a padded strap across the front of the chest. The middle bars embrace the upper part of the thigh, and the lowest encircle the leg, just below the calf. The splint is to be firmly bandaged to the body by a broad rib-roller, and to the lower part of the thigh and leg (fig. 208). This splint must be worn continuously, day and night, until all symptoms of disease have disappeared for at least three months. Those cases where the disease has been treated by confining the patient to bed for a longer period should also be supplied with a Thomas's splint for a time when they are allowed to get up.

The period during which treatment must be continued varies with the case. But it may be taken as a good rule that twelve months should always be allowed to elapse from the commencement of treatment before the patient is allowed to move the joint, and sometimes the treatment will have to be carried on for two or three years.

In cases of young children who are unable to walk about on crutches, a double Thomas's splint is the best appliance. This immobilises the limb and keeps it in a straight position, and still the patient can be carried about and taken out in the open air.

During the whole of the time that this local treatment is being carried out, the strictest attention must be paid to the general health of the patient, so as to maintain it in as sound a condition as possible. The patient, if it can be so arranged, should live in the country, and especially at the seaside. If he is about on crutches he should be in the open air as much as possible; and if confined to bed, in the case of children, arrangements should be made to carry the bed into the open air during the summer months. The diet should be attended to, good plain nutritious food being given. The secretions must be regulated, and tonics, especially cod-liver oil and iodide of iron, administered.

In those cases where in spite of treatment suppuration occurs, or where it has already taken place when the case first comes under treatment, the matter should be evacuated at as early a period as possible by an antiseptic incision; but opinions differ very widely as to whether anything more than this should be done. Some surgeons adopt the expectant treatment, and simply drain the abscess, paying strict attention to maintaining its asepticity, and continuing the same absolute rest and constitutional treatment. If fresh abscesses form they must be opened in the same way. There is no doubt that, by adopting this plan of treatment, a case may occasionally recover, but the surgeon who follows it out must be prepared for many failures; in spite of every precaution the time will come when, in many of these cases, decomposition will set in, the sinuses will become putrid, and the soft parts being riddled by them, the time when excision is likely to prove of advantage has gone by, and the case will then assume a very serious aspect. Moreover, it would appear that the results obtained after excision are as good as those obtained by the expectant treatment, and at a much less sacrifice of time; the average duration of cases of suppuration dealt with by the expectant method, which recovered, being about four years, whereas after

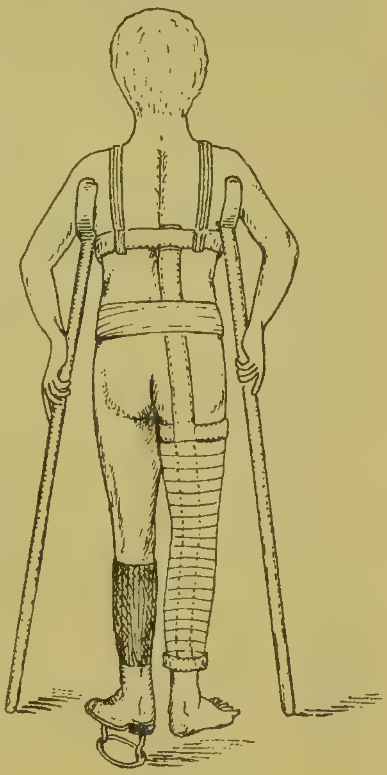


Fig. 208.
Thomas's hip splint applied.

excision the patient is soon in a position to move about and get into the fresh air, and will probably be able to bear the weight of his body on the limb in from six to twelve months. The line of treatment which I adopt in those cases where disease of the hip has gone on to the formation of matter, is to open the abscess freely by an incision which will expose the joint; and, if there is destruction of the joint surfaces, to remove the head of the bone and thoroughly scrape away all the diseased structures. The removal of the head of the femur is a necessity, even in those cases where the disease has commenced in the synovial membrane, because otherwise the diseased synovial tissue at the back of the joint cannot be completely removed.

Excision of the hip is rarely required for conditions other than tuberculous disease. It may be excised by an anterior, external, or posterior incision. Of these three methods, the one by the anterior incision is to be preferred, since it can be performed without wounding any important structures, and interferes very little with the capsule. The objection which has been raised to it, that it does not provide efficient drainage, is of little importance, since no drainage is usually required. An incision is made from half an inch below and external to the anterior superior spine downwards and inwards, along the outer border of the sartorius muscle (fig. 209); this is deepened, carrying the knife between the sartorius and the tensor vaginæ femoris; then between the gluteus minimus and the rectus, and the abscess is opened. This is generally done before the capsule is incised. The abscess is to be scraped, and flushed with Barker's flushing gouge (fig. 25), with sterilised water at a temperature of 105° F., and all broken-down matter washed away. The capsule is now opened, and the joint explored with the finger. An Adams's saw (fig. 201) is applied to the neck of the bone, and it is sawn through and the head removed with sequestrum forceps. If the head of the bone is lying loose in the cavity, as is not uncommonly the case, a fresh section of the neck, beyond the point of separation, should be made with the saw so as to obtain a clean surface. The whole of the interior of the joint is to be well scraped with the flushing gouge, all flakes of cartilage and carious bone being removed from the acetabulum, and all granulation tissue got rid of. If the acetabulum is perforated, the opening should be enlarged, so that the gouge can be introduced through it, and the intra-pelvic part of the abscess scraped and flushed. After the whole of the cavity has been cleaned, a sponge is to be introduced to arrest oozing, and the sutures inserted but not tied. The limb is now abducted and the sponge removed; the joint is filled with iodoform emulsion, and the sutures tied. No drainage tube is necessary, but some surgeons prefer to use one for a couple of days. The wound is dressed, with plenty of wool and a spica bandage so as to make elastic pressure, and the limb, abducted slightly, put up on a double Thomas's splint. In the majority of cases, no

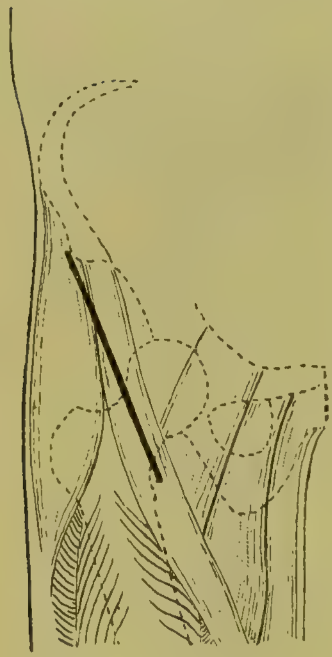


FIG. 209.—Diagram showing the line of incision in excision of the hip.

dressing will be required for ten days, when the wound will probably be found to be healed. The stitches are removed and the part re-covered with wool and a bandage, so as to continue the elastic pressure. If the patient is a child, he can be carried into the open air on his splint, which should be worn for three months, the object being to procure as firm a joint as possible. At the end of three months the splint may be discarded and the patient allowed to go about on crutches, with the foot of the sound limb raised on a patten. He should not attempt to bear his weight on the excised joint for six months. If there is any tendency to flexion, the splint should still be worn at night.

In those cases of old-standing hip disease where there is extensive caries and numerous sinuses discharging foul pus, excision is of no use; all that can be done is by long-continued rest and cleanliness, with drainage, and supporting the general health, to endeavour to tide the patient over a protracted illness. Should he present symptoms of running downhill, or develop signs of commencing lardaceous disease, amputation at the hip joint may be adopted as a last resource.

The knee joint.—Simple acute synovitis is of common occurrence, on account of the exposed position of the joint and its liability to injury. When effusion takes place, the knee presents a rounded outline, with all the natural hollows filled up. There is also considerable swelling on the front of the lower part of the thigh, more marked on the inner than on the outer side. The most marked sign of effusion into the knee is floating of the patella; this bone is raised from the condyles of the femur by the fluid, and on pressing it smartly backwards, can be felt to tap against the intercondyloid notch.

In cases of suppurative synovitis, early incision and washing out of the joint must be practised. This is usually done by two incisions towards the posterior part of the lateral pouches of the synovial membrane. Some surgeons prefer a horseshoe-shaped incision, dividing the ligamentum patellæ, which is afterwards sutured, as giving freer access to the joint. But this is an unnecessarily severe proceeding, as careful flushing through two lateral incisions will cleanse the joint, and, if the operation is undertaken early enough, will in a certain number of cases be followed by perfect recovery and a complete restoration of the functions of the joint.

Ankylosis of the knee may be either fibrous or bony. When fibrous ankylosis is recent and is not too firm, much may be done by passive motion and massage to restore the movements of the joint; but in cases of old strong fibrous ankylosis in an extended position, it is well not to make any attempt to break down the adhesions under chloroform in order to attempt to obtain a movable joint. There is a great probability of the adhesions re-forming, and it may be that they will do so with the limb in a less advantageous position. If the ankylosis which has taken place is faulty,. then the position must be corrected. In cases of not very firm fibrous union, this may be done by breaking down the adhesions under an anæsthetic. In doing this, care must be taken to break them down by a movement of flexion rather than extension, as cases have occurred where the popliteal artery has been ruptured by breaking down adhesions of old standing in the knee joint by a movement of extension. Where the union is very firm, fibrous, or bony, the position must be corrected by removing a wedge-shaped piece of bone, including the remains of the old joint. A transverse incision is made across the front of the joint down to the bone, and its surface exposed. Two sections of the bone are then made with the saw, the upper one at right angles to the axis of the femur, and the lower one at right angles to the axis of the tibia, in such a manner that the two sections terminate at the same point on the posterior surface of the bones. The wedge-shaped piece of bone included in these two sections is removed, and the sawn surfaces of the tibia and femur adapted to each other and pegged together. The external wound is sutured, the dressings applied, and the limb put up in a Croft's plaster of Paris splint. Union of the bones takes place, but the limb should be kept in a plaster of Paris casing until it is quite firm.

With regard to the other diseases of the knee joint, with the exception of tuberculous disease, nothing further need be said, as they have already been sufficiently described in speaking of diseases of the joints generally.

Tuberculous disease of the knee joint is a common affection, though it does not occur as frequently in the knee as in the hip. Unlike the corresponding disease in the hip, the morbid process in these cases most frequently commences in the synovial membrane. In the early stage the swelling partakes of the shape of the synovial membrane, and in some cases is attended with considerable effusion into the synovial sac; generally, however, the effusion is only slight, and is chiefly apparent on either side of the ligamentum patellæ. Later on the swelling becomes globular, and the knee bent at an angle, and though it can be flexed, it cannot be completely extended. After the ligaments become softened and partially replaced by granulation tissue, a partial displacement takes place; the bones of the leg being displaced backwards and outwards and at the same time rotated outwards, so that the foot is everted, mainly through the action of the biceps muscle. Tuberculous disease of the knee, commencing in the osseous tissues, is of more common occurrence in early adult life than in children. In these cases the movements in the earlier stages are free, and there is no swelling, beyond perhaps a little enlargement of the affected bone; but there is pain, especially when the weight of the body is laid on the affected limb, and upon jarring the limb by blows on the heel. There is also lameness and starting of the limb at night.

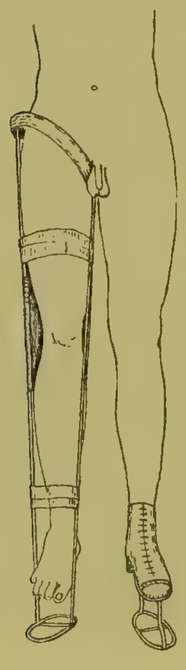


FIG. 210.
Thomas's knee splint.

Treatment.—The measures to be adopted are the same as those recommended in tuberculous affections of other joints, namely, absolute rest, and not only must the joint be immobilised, but the patient must be forbidden to put his foot to the ground, so that no condition of unrest shall be induced by pressing the articular surfaces together. The best means of attaining this end is by means of a Thomas's knee splint, so that the patient can be allowed exercise, and still the knee joint is prevented from moving, and no weight is thrown upon it (fig. 210). In addition to this, if thought desirable, extension can be made by attaching an india-rubber accumulator to the foot and to the cross-bar of the foot-piece of the splint. Thus treated, early disease will in a considerable number of cases subside, and if the treatment is persevered with for a sufficient length of time, complete recovery will take place with unimpaired movement of the joint. If in spite of treatment the disease progresses and there are signs of softening and abscess formation in the pulpy tissue, or if the tibia becomes displaced backwards and outwards from the femur, operative interference will generally be called for. It may be that before the actual stage of softening is arrived at,.it may be desirable to try those measures spoken of above, as the injection of iodoform emulsion or Bier's method of elastic bandaging, but when the caseous foci have developed into abscesses nothing short of operation is of any use. Three different plans of treatment by the knife are spoken of: (1) arthrotomy; (2) erasion or arthrectomy; (3) excision. Arthrotomy is not an operation which commends itself, as the removal of the granulation tissue can be only very partial, but has been followed by success in the hands of some surgeons. Erasion is especially applicable to those cases where the disease begins in the synovial membrane, and the surgeon's aim is to leave a movable joint, and his object to remove diseased structures, and diseased structures only. The main objection to this operation is that if after its performance a movable joint is obtained, it is a very unstable one and not fit to bear the weight of the body, so that it is better, I believe, in all cases to remove the articular cartilages and aim at getting osseous union of the two bony surfaces and a firm limb capable of supporting the weight of the body. This is done by the operation of excision, which not only has for its object the removal of all diseased parts, but also a thin slice of bone from the ends of the femur and tibia.

Excision of the knee is most frequently required for tuberculous disease, but may also be called for in some instances of disorganisation after pyæmia, rheumatic fever, &c.; in osteo-arthritis; in old neglected infantile paralysis, where there is a flail-like distorted limb (Wright); and in cases of compound fracture, especially from gunshot wounds.

There are many ways of performing the operation: (1) by a transverse incision through the patella, with or without removal of the bone; (2) by a horseshoe-shaped incision, dividing the ligamentum patellæ; (3) by a vertical incision. The mode of operating by a transverse incision through the patella will be described here, as it is the one which I always perform, but the essential steps in the operation after the joint has been opened must be understood to be the same in every case. This operation gives a free access to the joint, and there is no difficulty in reaching the deeper parts. It is desirable, if the patella is not much diseased, to retain it, and after removal of its articular surface to suture the divided halves together; by this means the insertion of the quadriceps is preserved, and the action of the hamstring muscles is counterbalanced. An incision is made across the limb, over the centre of the patella, from one condyle to the other (fig. 211). The capsule of the joint is opened on either side of the bone, and this is then sawn through. The joint is thus freely opened, and the knee being flexed to a right angle, the knife is introduced into the cul-de-sac of the synovial membrane beneath the quadriceps, and the capsule freely divided in a vertical direction on either side of the patella. By now grasping the upper sawn end of the patella and pulling it upwards, the whole of the pouch can be exposed, and with a pair of toothed forceps and a knife can be dissected cleanly away. This having been done, the surgeon proceeds systematically to dissect away the whole of the pulpy tissue first on one side of the joint and then on the other, and gradually works his way forwards to the front of the articulation. Now, by making a vertical incision through the capsule from within outwards on either side of the ligamentum patellæ, and pulling downwards the lower half of the patella, he can clear away all the pulpy tissue from between the ligament and the front of the tibia. In this manner every particle of diseased tissue which is visible having been removed, attention is directed to the articular surfaces. The patella is first examined, and if, as is generally the case, only its articular surface is superficially eroded, a thin section should be cut from this; if it is extensively diseased the two halves should be removed. The section of the femur is then made, the knee is fully flexed, the femur held steady, and the saw applied to the front of the condyles so as to remove their lower halves and no more, for fear of injuring the epiphysial cartilage. The section of the bone should be made parallel to the articular surface, and as the section is being carried through the thickness of the bone, the saw should be slanted slightly upwards, so as to remove a little more behind than in front. When the bones are brought together this will cause the limb to assume a slight degree of flexion, which is the most desirable position for progression; an absolutely extended limb causing the heel to catch in the ground during walking. The upper end of the tibia is now to be removed. It is protruded from the wound by an assistant and held steady, while a thin slice, never more than half an inch in thickness, is sawn off. Care must be taken on nearing the posterior border of the bone to avoid wounding the popliteal artery. After the bones have been sawn, the cut surfaces must be carefully examined and any carious tissue must be gouged away, no further sections of the bones being made. The back of the joint now requires to be taken in hand. This is the most difficult part of the operation, for not only is it difficult to reach all the recesses and folds of the synovial membrane in this situation, but in addition the operator is in close proximity to the popliteal artery, so that care must be taken not to cut too deeply and injure this vessel. With care, however, every particle of diseased tissue can be removed, and the surgeon should not be satisfied till this is done. The exposed surfaces should now be thoroughly douched, to wash away any débris of tissue, the halves of the patella drilled and united with chromic gut. The bones are now placed in accurate apposition, the surface of the femur against which the patella rests having been first freshened so as to secure bony ankylosis. In the majority of cases I believe it is of advantage to peg the two bones together. A small incision is made on the inner and outer surfaces of the tibia, just below the tuberosities, down to the bone, and long ivory pegs, which have been well boiled, are driven through the tibia into the femur in an oblique direction, so that they cross each other in their course: the ends are cut off close to the bone and buried. The external wound is now closed with sutures, no drainage tubes, as a rule, being required, and dressed. After the operation

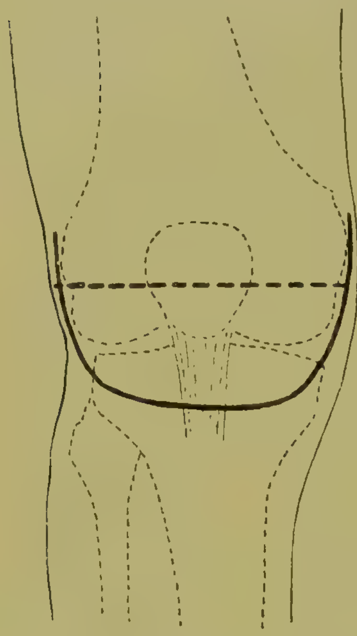


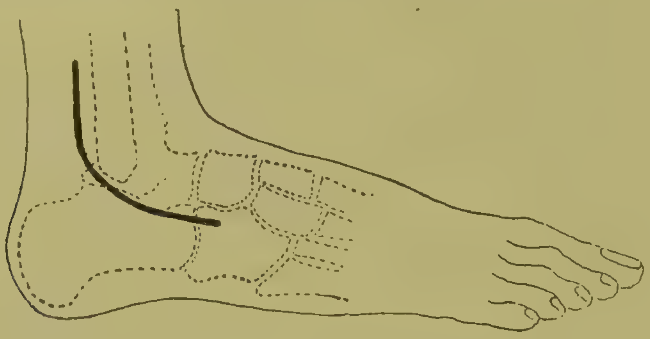
FIG. 211.—Diagram showing the lines of incision, by the transverse and horse-shoe methods, in excision of the knee.

it is essential that the parts should be kept absolutely quiet for some weeks, and for this purpose the splint devised by Howse is well adapted. It consists of two interrupted metal troughs for the thigh and leg joined by a bar behind the knee. This bar may be bent, so as to allow of the slight flexion alluded to above. This splint is fixed by 'waxed' bandages, prepared by soaking them in a mixture of olive oil and wax. My own practice consists in putting the limb up in Croft's plaster of Paris splint, which keeps the parts absolutely quiet, and can be easily removed and readjusted for dressing. The splint must be retained until the bones are firmly united, and then a moulded leather splint must be worn for at least a couple of years, as there is a great tendency for the leg to become gradually flexed on the thigh from the action of the hamstring muscles, and from the weight of the leg when the patient is in the sitting position, with the thigh resting on the seat of the chair.

The **ankle joint** is not so frequently the seat of acute simple synovitis as are some of the other joints. When it does occur the principal and most characteristic swelling is on either side of the tendo Achillis, between it and the malleoli, but there is also swelling in front of the joint on either side of the extensor tendons. In cases of suppurative synovitis there is great difficulty in obtaining free drainage, and these cases often require amputation.

In **tuberculous disease of the ankle joint** the morbid process may begin either in the synovial membrane or in the bones. The swelling in these cases principally shows itself as a pulpy enlargement on either side of the tendo Achillis, and also sometimes in front of the joint, displacing the extensor tendons forwards. It is sometimes extremely difficult to determine whether the disease is in the ankle joint or is confined to the tarsal bones, the astragalus or os calcis, or to the astragalo-calcanean joint between the two. The presence of a pulpy swelling on either side of the tendo Achillis is the best guide to a correct diagnosis. The treatment in the early stage consists in rest and attention to the general health. The joint should be inclosed in carefully moulded leather splints, and the patient enjoined to go about with a knee-rest, so that no weight may be borne on the limb. In cases where the disease progresses, and chronic abscesses have formed, arthrectomy, in which the joint is freely opened and all diseased structures removed, has been followed by satisfactory results ; but formal excision of the ankle joint has not proved a favourable operation, as the disease in the ankle joint is often associated with disease in the tarsal bones, and even if the wound heals, a very useless foot is often the result, so that Syme's amputation, which leaves a most serviceable stump, is more frequently resorted to in cases requiring operation. In performing arthrectomy the joint may be opened by a transverse incision across the dorsum of the foot, the divided tendons and nerve being subsequently sutured, or by longitudinal incisions in front of either malleoli, or by four vertical incisions, one in front and one behind each malleolus. The first-named plan gives the freest access to the joint, but has the disadvantage that it divides important structures.

Excision of the ankle joint.—The ankle joint is excised for tuberculous disease, and in some cases of compound fracture into the joint, where the injury is limited to the bones entering into the formation of the articulation, and the patient is young and healthy. The operation is best performed by two lateral incisions, so that no important structures are divided. The foot is first turned on its inner side, and an incision is made immediately behind the lower 2½ inches of the fibula, as low as the tip of the malleolus, and is then curved forward along the outer side of the foot to within an inch of the tuberosity of the fifth metatarsal bone (fig. 212). The flap thus formed is dissected forwards and the lower end of the fibula cleared, care being taken not to injure the peronei tendons. The external lateral ligament and the inferior tibio-fibular ligaments are now divided, and the fibula cut through with bone forceps about two inches from the tip of the malleolus, and the end removed. The wound is protected with a carbolised sponge, and the foot turned on its outer side. A similar semicircular incision is made down the posterior border of the tibia, round the inner malleolus, and along the inner side of the foot to the internal cuneiform bone. The flap is dissected forwards, and the extensor tendons, vessels and nerves separated from the front of the bones: then the flexor tendons and the posterior tibial vessels and nerve are separated from the malleolus and held out of the way with a blunt hook. The internal lateral ligament and the anterior ligament of the ankle joint are divided, and by forcibly everting the foot the lower end of the tibia is protruded from the wound and sawn off. Some surgeons now saw off the articular surface of the astragalus by means of a metacarpal saw held horizontally and passed from the inner to the outer wound; but it is better to remove the whole of the astragalus by opening the astragalo-scaphoid joint: then passing the knife between the astragalus and os calcis, and dividing the inter-osseous ligament, and finally twisting the bone out with lion forceps, aided by a touch or two with the point of the knife. After the operation



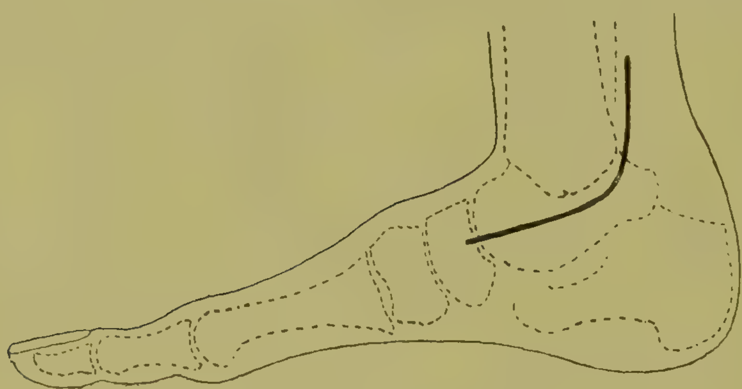


FIG. 212.—Diagram showing the lines of incision in excision of the ankle joint.

is completed, the foot must be kept at a right angle to the leg, and for some time encased in a plaster of Paris splint until complete consolidation has taken place.

Excision of thetarsal bone.—The tarsal bones may occasionally require removal for tuberculous disease of their cancellous tissue or of neighbouring joints. Planned operations are described for removal of the os calcis and astragalus: the other bones must be removed by the surgeon, by means of incisions framed to meet the exigencies of the case, especially in reference to the situation of any sinuses which may exist.

Excision of the os calcis may be performed in the following manner. An incision is commenced on the inner side of the tendo Achillis, on a level with the upper border of the os calcis, and carried horizontally round the heel, and forwards along the outer side of the foot to the calcaneo-cuboid joint, midway between the external malleolus and the tuberosity of the fifth metatarsal bone. This incision is carried deeply, and at once divides the tendo Achillis. A second vertical incision about two inches long is now made over the calcaneo-cuboid joint, so that its centre joins the extremity of the first incision. The flap of the heel formed by the incisions is separated from the external, posterior, and under surfaces of the os calcis, the point of the knife being kept close to the bone. The joint between the os calcis and the cuboid is opened, and the connections between the two bones severed. The knife is now introduced horizontally between the os calcis and the astragalus, and the strong interosseous ligament divided. The bone is seized with lion forceps and twisted downwards, so that the soft parts on the inner side of the bone can be separated, and the bone removed. The gap left is lightly plugged with gauze, and the wound united with a few points of suture. The only mark of the deformity left after recovery is a little elevation and shrinking of the heel.

Excision of the astragalus may be performed by a single straight incision from the anterior border of the outer malleolus, a little above the tip, to a point between the bases of the fourth and fifth metatarsal bones. This incision is carried down to the bones, and divides the peroneus tertius tendon. With a periosteal elevator the soft parts are now stripped from the outer and upper surface of the astragalus, and the external lateral and anterior ligaments of the ankle joint divided. The astragalo-scaphoid joint is opened, and the ligaments connecting the head of the astragalus to the surrounding bones severed. An elevator is introduced into the joint between the astragalus and scaphoid, and by depressing the handle the astragalo-calcanean joint is prised open, so as to permit of the introduction of the point of the knife between the two bones, and division of the interosseous ligament. The astragalus is now seized with a pair of lion forceps, and a few touches of the knife to divide the remaining fascial and ligamentous attachments frees the bone and allows of its removal.

CHAPTER VII

INJURIES AND DISEASES OF THE HEAD

INJURIES OF THE HEAD

In considering the subject of injuries of the head, it is convenient to classify them in their anatomical order, as (1) injuries of the scalp; (2) injuries of the bones of the skull; and (3) injuries of the contents of the skull. These accidents are always matters of importance, the injuries of the soft parts covering the skull, and of the bones themselves, deriving their importance from the lesions of the cranial contents which may either directly or remotely result therefrom.

I. INJURIES OF THE SCALP

Before describing the injuries to which the scalp is liable, it will be well to allude briefly to its anatomy. From an anatomist's point of view, the scalp would be roughly described as consisting of the skin and its appendages, of the occipito-frontalis and its intervening tendon, and of the pericranium; but from the surgeon's point of view there are two important layers of connective tissue: one, dense and fibrous in character, between the skin and aponeurosis, in which are contained the nervous and vascular supply to the scalp; and the other, loose and poorly supplied with blood, between the aponeurosis and the pericranium. This lower layer is so loose that it is easily torn through, and hence, when a flap wound occurs in the scalp, this is the tissue which is torn when the flap is separated from subjacent parts, and the vessels are torn down with it. The supply of blood to the flap is therefore good, and there is no chance of its sloughing, unless its vitality has been actually destroyed by the injury itself. In consequence of its loose nature and feeble vitality, any septic inflammation of this inferior plane of connective tissue is apt to assume a very diffuse form and spread all over the skull, and unless relieved by timely incisions lead to extensive destruction of the integument from the tension to which it is subjected.

Contusions of the scalp may be of three different varieties: (I.) In which the bruising is confined to the skin and subcutaneous connective tissue, and which differs in no respect from bruises in other situations. (II.) Where the extravasation of blood takes place into the connective tissue between the aponeurosis and the pericranium. As a rule, on account of the poor vascular supply to this tissue, these extravasations are not usually of any large size; though occasionally, especially in children, they may extend over a considerable part of the head. They derive their special interest and importance from their being liable to be mistaken for depressed bone. They consist of a soft fluctuating swelling surrounded by a hard and distinct margin, caused by the blood at the circumference becoming coagulated. This gives to the touch the impression of the edge of a fracture with depression. The diagnosis is to be made by bearing in mind that in fracture by passing the finger towards the sharp margin it passes at once from the level of the surrounding surface into the depression; but in blood tumour it passes up the elevated margin of the clotted blood before it reaches the sharp margin which bounds the central soft portion. (III.) Extravasations may take place under the pericranium, generally in infants, from direct violence during parturition, either from maternal structures or obstetric instruments. They are then termed *cephalhæmatomata*, and are confined to one bone, generally the parietal, and never pass beyond the sutures. They are soft, fluctuating swellings, sometimes with a hard margin around. They for the most part disappear in the course of a few weeks. Extravasations of blood into the sub-aponeurotic connective tissue may also occur as the result of injury during parturition. The swelling is then not necessarily confined to one bone, and may form large soft fluctuating swellings.

Treatment.—No treatment is necessary beyond the application of a lotion to promote absorption. The extravasation will probably be absorbed in time. If very extensive, so as to cause tension of the skin, it would be right to aspirate and relieve tension by withdrawing some of the fluid.

Wounds of the scalp.—Wounds of the scalp may be caused by sharp or blunt instruments, by falls on the head, or by gunshot injuries. The most common form is a contused wound, produced by a blunt instrument. But it must be borne in mind that, on account of the tenseness of the tissues, a blunt instrument may produce a sharp-cut, clean incised wound. Scalp wounds may be divided into three classes: (I.) Superficial wounds not penetrating the epicranial aponeurosis, which are of little importance and differ in no wise from wounds in other parts of the body; (II.) Wounds dividing the epicranial aponeurosis and opening up the loose cellular tissue beneath it; and (III.) wounds extending through the pericranium and exposing and probably more or less bruising the bone. Scalp wounds may, like wounds in other parts of the body, be incised, punctured, contused and lacerated, or large flaps may be torn down. These flaps, as pointed out above, rarely slough, and should never therefore be removed, however grimed with dirt and crushed they may be. The bleeding is sometimes free, when any vessel of size has been injured, but can usually be controlled by pressure unless the vessel has been merely punctured without being divided completely across, when repeated hæmorrhages may take place. This can always be at once arrested by dividing the vessel and applying pressure.

Complications.—Where a scalp wound, opening up the sub-aponeurotic connective tissue, is tightly closed so that the serous exudation cannot escape, the fluid forces its way into the spaces of the loose connective tissue and distends them. As this fluid is a highly putrescible animal matter, if any of the bacteria of putrefaction are present, it speedily decomposes and sets up a diffuse cellulitis of the sub-aponeurotic cellular tissue, which may spread all over the scalp. About the third or fourth day after the receipt of the injury, the edges of the wound become swollen and puffy, and the patient complains of pain in it. This swelling extends rapidly, and is of a dusky uniform redness; it presents a boggy sensation to the fingers, and after a time emphysematous crackling may be felt. The swelling may extend on to the face, the eyelids becoming œdematous and closed, and the nose swollen. The condition is accompanied by severe constitutional symptoms, which rapidly assume an asthenic type, and muttering delirium sets in with great depression of the vital powers. The inflammation of the cellular tissue terminates in sloughing, and through openings in the skin, made either by the surgeon's knife or by ulceration of this structure, masses of sloughing tissue are thrown off. The **treatment** of this condition consists in giving free exit to the effused material. In quite the early stage, when the wound is first noticed to be swollen and painful, any sutures which may have been inserted should be removed, and the wound freely opened up with a probe and a hot boracic fomentation applied. If this is done at the onset, the disease will probably be arrested ; but if the swelling spreads, free incisions must be made in the scalp down to the bone, to allow of the escape of matter and sloughs. Hot boracic fomentations should be constantly applied, and the patient's strength supported by good nutritious food, stimulants and tonics. In the third variety of scalp wound, where the pericranium is injured and the bone exposed, there is often more or less bruising and injury to the bone itself, which may lead to serious complications, though in many cases these injuries are recovered from without any evil consequences.

(1) When the pericranium has been extensively stripped off the bone, the blood supply to this structure is partially cut off and the external table of the skull, which receives its supply mainly from the pericranium, may necrose and exfoliate, but this is not necessarily the case. In many instances where a large surface of bone is exposed and becomes dry and white, after a time little vascular spots will appear upon it by extension of vessels from the deeper parts into it, and its vitality will be preserved.

(2) Another complication which may occur in those cases of scalp wound where the bone is injured, is a chronic ostitis. This may go on to sclerosis and great thickening of the skull. The patient apparently recovers from his injury and the wound heals, but he soon begins to suffer from a gnawing, aching pain in his head, which is worse at night and prevents sleep. This may go on for months, and as the bone becomes thickened symptoms of brain irritation appear, often showing themselves in the form of epileptic seizures.

(3) If suppuration occurs in the wound of the scalp, where the bone has been injured, the septic inflammation may spread through the bruised bone to the veins of the diploë, and a septic osteo-phlebitis is set up, which will almost immediately terminate in pyæmia. This condition, which formerly was of common occurrence, is now happily very rare, owing to the more rigid cleanliness which is observed in the treatment of wounds. The symptoms in these cases are recurrent rigors, with an irregular temperature, sweating, quick and feeble pulse, followed by chest or abdominal symptoms or swelling of the joints. After death, the diploë is found to be bathed in pus, with septic thrombi in the sinuses of the skull, and secondary abscesses in the lungs or other viscera.

(4) Another complication which may arise in these cases is an extension of the inflammation through the bone to the membranes or substance of the brain, and as a result intra-cranial suppuration. The suppuration in these cases may be, and generally is, either deeply seated in the white matter of the convolutions or on the surface of the brain in the subarachnoid space, and these cases will be considered later on. But in rare

instances the suppuration may occur between the bone and dura mater, where it forms a localised abscess, corresponding in situation to the external wound. These cases give rise to a definite train of symptoms, which must be briefly alluded to in this place. The symptoms generally occur before the wound has healed, but in some cases they may not appear until after this has taken place. They consist in intense pain in the head, with elevation of the temperature, delirium and vomiting, and probably a rigor. Conjoined with these general symptoms, if the wound has not healed, there is a cessation of the discharge and the wound becomes dry; the periosteum recedes from the bone, which is white and dry, and looks as if it were dead. The soft parts around are swollen and œdematous. If the wound has healed, the swelling and œdema, conjoined with the general symptoms, are the only signs. This tender circumscribed flattened swelling is known under the name of *Pott's puffy tumour*. The treatment in these cases consists in trephining and letting out the matter. Pott records eight cases as having occurred under his own care in which he trephined, and in five cases with success, but these cases are generally acknowledged to be very rare in these days, for even if matter is found between the bone and dura mater in a case of trephining for head injury, it is not generally limited or circumscribed, as in Pott's cases.

Treatment of scalp wounds.—In the treatment of a scalp wound the first indication is to arrest hæmorrhage from any large vessel which may have been wounded. The bleeding from small vessels will probably have ceased before the case is seen; if otherwise it can always be arrested by pressure. If a vessel has only been partially divided it should be cut across and then tied. In those cases where there is any difficulty in seizing the cut vessel in the brawny tissues of the scalp, it may be underpinned and compression made by a figure-of-8 loop. The wound and the parts around are now to be thoroughly cleaned, and as they are often deeply engrained with dirt, too much care and attention cannot be bestowed upon this. The hair for some distance around should be cut away, and the skin well scrubbed with soft soap and hot water. The edges of the wound if they are engrained with dirt should also be scrubbed. After this has been done the parts should be thoroughly soaked in a strong antiseptic fluid (carbolic acid lotion 1 in 20), or corrosive sublimate solution (1 in 1,000). After this has been satisfactorily accomplished, the edges of the wound are to be adjusted and united by sutures; the old prejudice against using sutures in scalp wounds being now quite exploded. The best material for suture is horsehair, but if a large and heavy flap has been torn down and these sutures are not strong enough to hold it, fine silk-worm gut should be substituted. The wound is now dressed with double cyanide gauze and wool, and bandaged. The dressing may be left on for a week or ten days if there is no pain or rise of temperature, and if the cleansing process has been efficiently carried out, at the end of this time the wound will be found to be healed, or if any of the tissues have been killed by the violence they will be found to be separating without suppuration, or with the smallest amount possible.

II. INJURIES OF THE SKULL

Fractures of the skull may be *incomplete*, that is, implicating one table of the skull only ; or *complete*, where the whole thickness of the skull is involved.

Incomplete or partial fracture of the skull is most commonly met with in those cases where the fracture occurs over the situation of some of the air sinuses of the bone, and where the external table forming the outer wall of the sinus is broken. Thus fractures over the frontal sinuses or the mastoid cells may belong to this class of partial fracture. They derive their principal interest from the fact that as these sinuses contain air, this may find its way through the broken bone, and permeate the subcutaneous cellular tissue, setting up a condition of emphysema. *Scratch* fractures, as they are called, also belong to this class. These are cases where the external table is slightly broken by a direct blow in cases of scalp wound, and belong to that class of case which has been already considered as the third variety of scalp wound, and lead to the same results. A third variety of incomplete fracture is where the internal table is fractured and often depressed, without any injury to the external table. In these cases no diagnosis can be made during life, and the patients generally die of intracranial mischief.

Complete fractures comprise the following varieties: (1) fissure, (2) comminuted fracture, (3) punctured fracture, (4) depressed fracture, (5) compound fracture, and (6) fracture of the base. All these fractures are produced by external violence, which may either be *direct*, where the skull yields at the point struck ; or *indirect*, where the force producing the fracture is not applied directly to the skull, as in a case where a man fractures the base of his skull by falling from a height on to his feet. A third doubtful way in which fracture may be caused is by what is termed *contre-coup*, where the vibrations caused by the injury meet at a point opposite to that struck, and produce a fracture in this situation.

1. **Fissure of the skull** is a crack in the skull, which, starting from the point struck, may often extend for a very considerable distance. It may be productive of no further symptoms than those of the shock of the injury, and gives rise to no signs by which its presence can be diagnosed. No doubt in many cases of injury to the head, in which symptoms of concussion have alone existed, a fissure has also been present, but its presence has been unsuspected. If the fracture is compound, then the existence of the fissure would be at once evident by the presence of a red streak, and would be felt by the finger nail carried over the surface of the bone. Even if a fissure is detected, no special treatment is called for. If it is compound, the most rigid care must be taken to preserve asepsis, as the patient's safety depends in a large measure upon this. Simple fissure in children is in rare cases followed by the formation of a fluctuating swelling under the scalp. This occurs in those cases where the dura mater has been torn in a line corresponding to the fracture, and the fluid contained in the tumour is cerebro-spinal, which finds its way out through the fissure in the bone. The swelling is translucent, becomes tense when the child cries, and sometimes pulsates. It can occasionally be reduced in size by pressure. The treatment is unsatisfactory ; the only thing that can be done is to aspirate and then apply pressure, in the hope that it will not refill.

2. **Comminuted fractures** are those fractures where the skull is broken up into several pieces at the point struck. These fractures are very often depressed; that is to say, the broken pieces of bone are depressed from their proper level and driven inwards, causing pressure on the brain and its membranes. They may assume several varieties; there may be several lines of fracture radiating from a central point, the part struck; or a circular or oblong piece of bone may be broken off by a circumferential fissure, and the portion of bone detached may be variously comminuted and depressed. When the portion broken is more or less circular the term *pond* fracture is given; when it is oblong the term *gutter* fracture is applied (fig. 213).

3. **Punctured fractures** are always of an important and dangerous nature. They are produced by a blow with a pointed weapon, as a dagger, a pick, or a pitchfork, and are of importance mainly because, though the external table may be only perforated by a small hole, the internal table will in all probability be greatly comminuted and splintered, and fragments of bone may be driven into the brain. In addition to this it may happen that the instrument which caused the injury may be embedded in the brain. Thrusts through the roof of the orbit and through the nose, with an umbrella, stick, or such like object, belong to this class of punctured wound. In these cases there is often an absence of symptoms at first, but later on symptoms of inflammation of the brain set in, and the case may prove fatal. Immediate trephining is called for in these cases, to remove the comminuted fragments of the inner table.

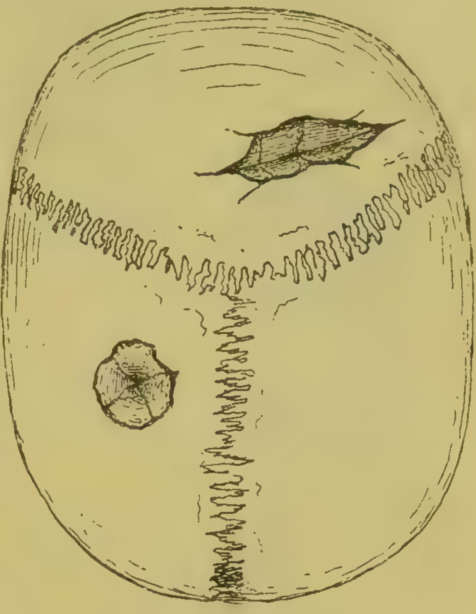


FIG. 213.—Diagrammatic representation of the *gutter* and *pond* depressed fractures.

4. **Depressed fractures** are those cases of fracture where the broken portion of bone is depressed below its proper level and driven inwards. They owe their importance to the injury to the brain or its membranes which they may cause. The symptoms which they produce are partly dependent upon the injury to the bone, and partly upon the laceration or compression of the brain, and these latter symptoms may or may not be present. When the fracture is a simple one, that is to say, without a wound of the soft parts over it, the existence of the depression is not always easy to ascertain; it may be felt, but, on the other hand, it may not be possible to feel it on account of the bruised condition of the scalp. If there are no symptoms of brain mischief, this is a matter of little moment; but if there are signs of compression of the brain, and there are any doubts on the matter, an incision should always be made in order to set the matter at rest. Of course, in those cases where the fracture is compound, the depression can always be felt with the finger or a probe. Cases of depression of the skull without any symptoms of compression of the brain are much more common in children than in adults. Large portions of

bone may be depressed to a very considerable extent in young children without producing any brain symptoms whatever, as in the case from which fig. 214 was taken; a child who was crushed between a mangle and the wall. The compression of the brain is partly due to the pressure of the depressed bone, and partly to the laceration and extravasation of blood into the brain substance.

5. **Compound fractures.**—The term *compound*, as applied to fractures of the bones of the skull, has the same meaning as in other fractures—that there is an external wound communicating with the lesion in the bone. These fractures are much more dangerous, especially if the bone is depressed, than the simple fracture. In these cases the great danger is not from the compression of the brain produced by the depressed bone, but from the septic inflammation which is apt speedily to follow: and if the dura mater has been torn by the depressed bone, the inflammation spreads to the sub-arachnoid space, and a diffuse septic meningitis is set up (fig. 215).

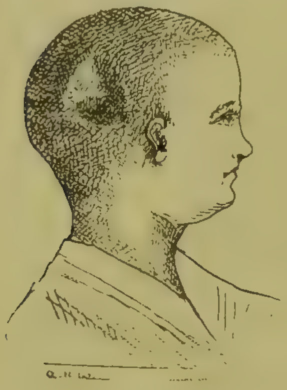


FIG. 214.—Depressed fracture of the skull in a child, without symptoms.

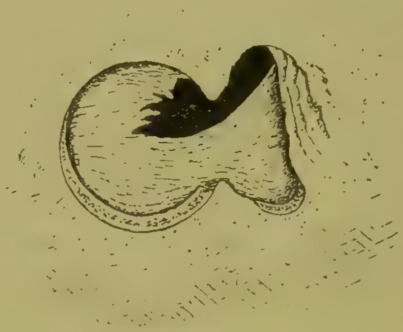


FIG. 215.—Drawing showing laceration of the dura mater from depressed bone. (From the Museum of St. George's Hospital.)

The **treatment** of cases of depressed fracture must vary as to their conditions. If the fracture is simple and there is no sign of any brain disturbance, operative interference is not indicated; but if the fracture is compound, even though no symptoms of irritation of the brain are present, the depressed bone should be elevated, not so much on account of any harm it might do from pressure, but in order that asepsis may be obtained and free drainage provided for, under which circumstances the risk of septic meningitis is very materially lessened. In all cases where there are symptoms of brain pressure, elevation of the bone should at once be resorted to.

Operation for elevating depressed bone.—In some cases all that is necessary is to insert an elevator under the depressed fragment, and lever it up into position. But in most instances something more than this is required; the depressed portion of bone is generally driven somewhat under the bone in the neighbourhood, which overlaps it, and this has to be removed before the bone can be elevated. Sometimes this may be done by sawing off the overlapping margin with a Hey's saw: in other cases a crown of bone, or perhaps more than one, has to be removed with a trephine. No definite rules can be laid down: each case must be dealt with on its merits, according to the discretion of the surgeon. In cases of punctured fracture a large trephine should be used, so that the whole circle of injured bone may be removed.

Before leaving this subject, it is necessary to mention a peculiar fracture of the vault of the skull, where a portion of the bone is elevated. This usually arises from a sabre cut, or a sharp instrument, like a chisel, falling from a height; a portion of the skull is then prised outwards, and resembles the lid of a box (fig. 216).

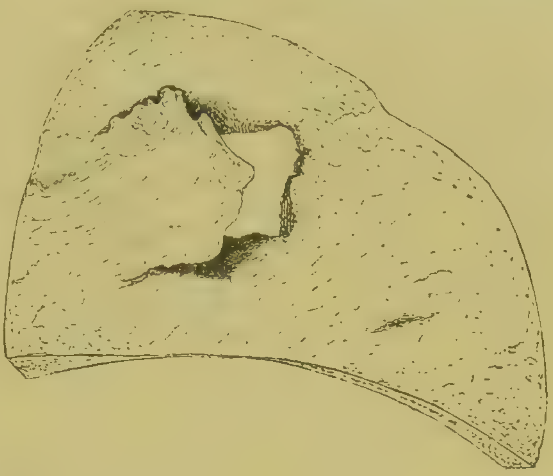


FIG. 216.—Elevated fracture, caused by a chisel falling perpendicularly from a height of about 80 feet. (From the Museum of St. George's Hospital.)

6. **Fractures of the base** constitute a most serious and important class of fractures of the skull, and may be produced in two different ways. (1) By *direct* violence, applied to the base of the skull. In this way the skull may be fractured by the direct impact of the vertebral column against the occipital condyles in falls upon the feet or buttocks; or by blows on or violence of any sort applied to the lower jaw, which drives its condyle against the glenoid fossa, and causes fracture of this part of the base of the skull; or, thirdly, by direct thrusts through the orbit or nose, causing fracture of the anterior fossa of the base of the skull. (2) Fractures of the base of the skull may also be occasioned by *indirect* violence; as, for example, when a person falls from a height on to his head and sustains a fracture of the base. The mechanism of this form of fracture was formerly explained by the doctrine of *contre-coup*; but, as we have already stated, there is no evidence to prove that this ever takes place, and it was superseded by what is usually known as Aran's law—that all fractures of the base are produced by a fissure which starts from the point of injury, and radiates to the base by the shortest route. This view was almost universally adopted for many years, and there can be little doubt that most cases of fracture of the base are caused in this way; but more extended observation has indisputably proved that there are some cases of fracture of the base in which there is no fracture of the vault, and where therefore the lesion cannot have been produced in this manner. In order to explain these cases, another theory has been proposed, which is known as the *compression* or *bursting* theory. The skull is an elastic sphere, and when compression is applied to it, its diameter will be reduced along the line of greatest pressure, and will therefore of necessity be increased in other directions, and may increase to such an extent that bursting may result: just in the same way that if a weight be placed on a hollow elastic ball, the ball will be compressed from above downwards and bulge laterally, and if the weight is sufficient will eventually burst in the situation in which it bulges. The skull being of unequal thickness, the tendency to bursting occurs in the weaker parts. In this way an attempt is made to explain those cases of fracture of the

base of the skull where no fissure can be found radiating from the point struck.

The dangers from fracture of the base of the skull do not arise from the fracture *per se*, but from the concomitant cerebral injury, either laceration or pressure from extravasated blood, or from the risk of septic meningitis being set up, as most of these fractures are compound. Those in the anterior fossa are rendered compound when there is a perforating wound through the orbit; or when the fracture runs across the cribriform plate of the ethmoid, and the soft structures covering its nasal surface are lacerated; or when the frontal or ethmoidal sinuses are opened. Fractures in the middle fossa are compound when the tympanic cavity is involved and the membrana tympani ruptured, or the fracture runs across the pituitary fossa, and the naso-pharynx is opened. Fractures in the posterior fossa are not usually compound, unless they extend across the basilar process of the occipital bone, and open up the roof of the pharynx.

Symptoms.—In describing the signs of fracture of the base of the skull, it will be convenient for purposes of description to allude to them as they occur in the anterior, middle and posterior fossæ respectively. And we shall commence first with those in the middle fossa, as this is by far the most frequent situation in which the fracture occurs. Before doing so, however, it is necessary to mention that any injury sufficiently severe to cause a fracture of the base will be severe enough to cause injury to the cranial contents, and therefore in most cases there are the signs of concussion, and in some of compression or laceration of the brain. Cases do, however, occasionally occur in which, though there is undoubtedly a fracture of the base, there is no evidence of any cranial injury.

Fracture of the middle fossa of the base of the skull.—In considering the signs of fracture of the middle fossa we will take a typical case of a person who falls from a height on to his head, striking the ground somewhere in the neighbourhood of the parietal eminence. The fissure, starting from the point struck, runs downwards through the parietal bone and the squamous portion of the temporal bone to the petrous bone, across which it runs to the middle lacerated foramen. In its course across the petrous bone, it involves the internal auditory meatus and the tympanic cavity, and the membrana tympani is also usually torn. Having reached the middle lacerated foramen, it may stop there, or it may pass across the pituitary fossa to the middle lacerated foramen on the opposite side, and indeed may travel onwards, following the same route on the opposite side of the head and back to the point from which it started. Thus the skull can be completely divided into two parts (fig. 217). The classical signs of such a fracture are: (1) hæmorrhage; (2) escape of cerebro-spinal fluid or brain matter; (3) evidence of lesion to some of the cranial nerves.

1. The blood may come from the external auditory meatus, from the nose, or it may be swallowed and subsequently vomited. When it comes from the external auditory meatus, it finds its way from the fracture into the tympanum, and passing through the ruptured membrana tympani is discharged externally. In order to be of any use as a means of diagnosis, it 'must be continuous and it must be profuse' (Hewitt). Under these circumstances it becomes an important diagnostic sign, but the trickling of a few drops of blood from the ear means nothing, and may arise from some slight injury to the ear itself. When the bleeding comes from the nose, it indicates that the pituitary fossa has been fractured, and that the

blood has found its way from this into the naso-pharynx. Most of the blood poured out in this way trickles down the pharynx and œsophagus into the stomach, from which it is after a time expelled by vomiting; so that the amount of bleeding from the nose is usually slight.

2. The escape of cerebro-spinal fluid from the external auditory meatus is not a constant, but when present is a most characteristic sign of fracture of the middle fossa. It indicates that the arachnoid has been torn, and the portion of this membrane which usually suffers is the prolongation around the facial and auditory nerves as they lie in the internal auditory meatus when the fracture runs across this canal. The fluid may be mistaken for the liquor Cotunnii, or for serous exudation in cases where inflammation of the middle ear has been set up; but the fluid in these cases is usually small in amount, whereas the pouring out of cerebro-spinal fluid may amount to ounces. Its true nature can be readily ascertained, since it contains a substance resembling grape sugar in giving a brick-dust precipitate when boiled with cupric oxide. Occasionally, in very severe fractures, small portions of brain matter may escape from the external auditory meatus. When this occurs it is absolutely diagnostic of fracture of the base.

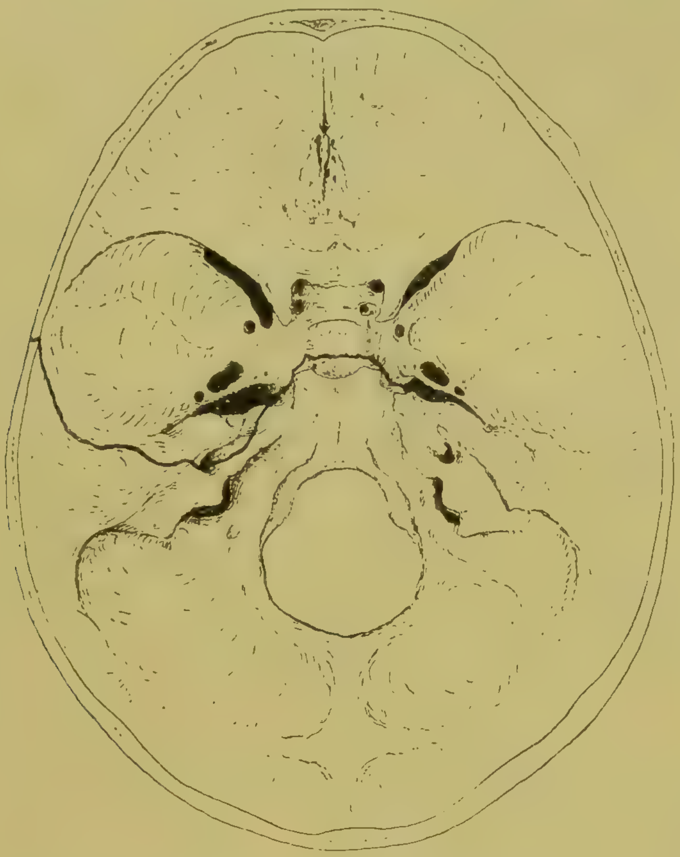


FIG. 217.—The base of the skull, showing the route usually taken by a fracture of the middle fossa.

3. In fracture of the middle fossa of the base of the skull there are often signs of paralysis of the muscles of expression and deafness on the affected side, from injury to the facial and auditory nerves as they lie in

the internal auditory meatus. The symptoms may be present from the first, and may be very marked, when they denote laceration or contusion of the nerves; or they may not come on for some days, when they are probably due to compression of the nerves by blood clot or inflammatory exudation, and under these circumstances they usually disappear in the course of time.

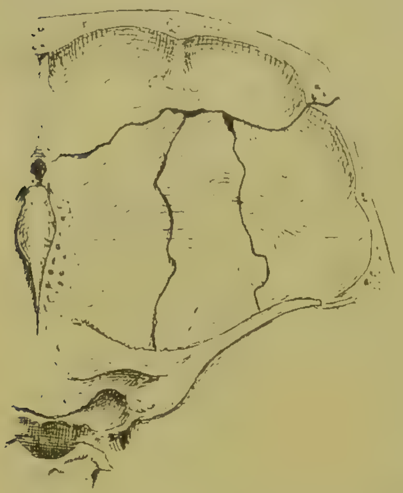


FIG. 218.—Fracture of the anterior fossa of the base of the skull. (From the Museum of St. George's Hospital.)

Fractures of the anterior fossa of the base of the skull.—These fractures may involve the orbital plate of the frontal bone, the cribriform plate of the ethmoid, and the lesser wing of the sphenoid (fig. 218). When the fracture involves the orbital plate of the frontal bone, the main sign is sub-conjunctival ecchymosis. The blood poured out at the seat of fracture finds its way into the orbit, and then travelling forwards appears on the front of the eye-ball under the conjunctiva. The sub-conjunctival ecchymosis in these cases extends backwards as far as the eye can reach, and there is usually no bruising of the upper eyelid, and in this way it can be diagnosed from the ecchymosis of an ordinary 'black eye.' There is usually in these cases a certain amount of proptosis or prominence of the eyeball from its being pushed forwards by the blood behind. In cases where the fracture of the bone has been produced by a thrust from without and is therefore compound, escape of brain matter may take place from the wound. When the fracture implicates the cribriform plate of the ethmoid, continuous and profuse bleeding from the nose is the main symptom, and in addition to this there may be escape of cerebro-spinal fluid or brain matter from the nose. In these fractures the frontal sinuses may be opened, and if the fracture extends into the supra-orbital arch, emphysema of the areolar tissue of the scalp may be present. If the fracture involves the lesser wing of the sphenoid, the optic nerve and possibly the motor-oculi nerve may be involved, producing blindness, ptosis, mydriasis, &c., and sometimes in fractures through the cribriform plate there is loss of smell from implication of the olfactory bulb.

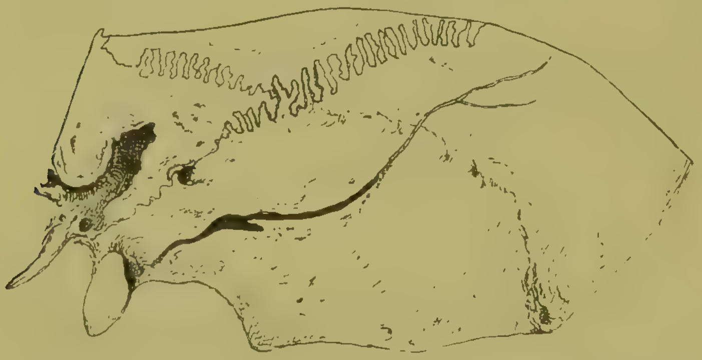


FIG. 219.—Old fracture of the posterior fossa of the base of the skull. (From the Museum of St. George's Hospital.)

The signs of **fracture of the posterior fossa** of the base of the skull are not very definite (fig. 219). There may in some cases be bleeding from the mouth, or blood which has trickled down the pharynx may be vomited in large quantities. Later on, deep-seated ecchymosis may appear among the muscles at the back of the neck, or in the neighbourhood of the mastoid process. The cranial nerves are rarely affected in these cases.

Treatment.—The main danger in fractures of the base of the skull is septic meningitis, and therefore the treatment should aim at preventing this as far as possible. Unfortunately not very much can be done, since it is impossible to apply antiseptic dressings to the naso-pharynx; but it would appear that the most frequent source of contamination is through the external auditory meatus, for since antiseptic surgery has been brought to bear on this part, the mortality from fracture of the base has very much decreased. The external meatus should be thoroughly syringed out with a strong antiseptic solution, plugged with antiseptic gauze, and a large pad of the same material applied over the side of the head. At the same time the nares and throat should be sprayed with antiseptic lotions. Beyond this, treatment must be directed to the cerebral condition; perfect quietness, a darkened room, low diet, and a brisk mercurial purge.

INJURIES OF THE CONTENTS OF THE SKULL

Concussion.—The word *concussion* is used in a clinical sense to indicate those cases where, as the result of an injury, the functions of the brain are temporarily suspended, so that the patient is stunned and rendered more or less insensible. The term was first used because there was believed to be in these cases a shaking up, or molecular disturbance of the brain substance, without any visible lesion, or any laceration of its substance or its vessels. But there is no evidence to prove that this is so, but such evidence as there is tends to prove exactly the opposite, for in nearly all cases in which death has occurred after concussion of the brain, more or less bruising of the substance has been found. At the same time it must be conceded that there is good reason for believing that this bruising is not the cause of the insensibility; for, as Sir William Savory points out, the insensibility passes away, while the bruising is still present; and, further, the amount of bruising is often not sufficient to cause the symptoms, and is often found in other cases where there has been no insensibility. A more probable theory of the cause of the insensibility in concussion is that it is due to a disturbance in the circulation, producing a condition of anæmia. But the way in which this anæmia is produced is not very clear. The latest theory on this subject is Daret's, who believes that as the result of the injury to the elastic skull there is a temporary depression of its walls, and this has a tendency to drive the cerebro-spinal fluid from the lateral and third ventricles into the fourth, so that it becomes distended, and this distension stimulates the bulb and produces a reflex anæmia of the brain.

Whatever may be the correct explanation of its causation, the word *concussion* includes a well-marked group of cases in which there is insensibility of a temporary character, unaccompanied by paralysis—in contradistinction to another group of cases in which there is insensibility of a more permanent character, accompanied by paralysis. These latter are cases of *compression*. The amount of insensibility may vary very much; from a momentary loss of consciousness, amounting to scarcely more than giddiness, with perhaps temporary loss of sight or flashes of light before the eyes and confusion of thought for a few moments, to absolute unconsciousness, during which the patient may die.

Symptoms.—The symptoms of concussion are those of surgical shock (page 40) with additional brain symptoms. The patient lies insensible, this insensibility being sometimes complete; at others it may not be quite complete, so that the patient can be roused by shouting, and will evince pain upon being pricked or pinched. In all cases the insensibility is sudden, and comes on immediately after the receipt of the accident. The pulse is weak, often irregular and sometimes cannot be felt. The skin is cold and clammy, and the temperature subnormal. The muscles are relaxed and the limbs flaccid, but there is no paralysis. The pupils are equal, generally somewhat dilated; they respond to light, though it may be sluggishly. The respirations are feeble and shallow, and irregular in rhythm. The sphincters of the bladder and rectum are relaxed, and there may be involuntary evacuation of urine and fæces. This is the first stage, that of collapse, and during it the patient may die, apparently from failure of the heart's action.

Sooner or later the stage of reaction comes on. This is generally in from ten minutes to half an hour, but it may be delayed for hours or even days. The first sign of returning consciousness is, in many cases, vomiting. The pulse becomes stronger; the patient takes deeper inspirations, and the surface of the body becomes warmer. He can now usually be roused, though with difficulty. As consciousness becomes more and more complete, he complains of headache, which may continue for days, and usually lies in a drowsy state, taking no notice of what is going on around. The temperature speedily rises and gets above normal, but scarcely ever above 100° F., and in the course of two or three days in an uncomplicated case falls again to normal. For some days the patient is stupid and drowsy, his countenance has a dull, heavy look, and he complains of giddiness if he raises his head from the pillow. These symptoms gradually pass off, and the case terminates in complete recovery. The only sign which remains and marks the condition is that there is an entire loss of memory of the accident. The patient will tell you that he remembers slipping or falling and nothing more.

Some cases of concussion, however, do not terminate in complete recovery, but a condition of what has been termed *traumatic neurasthenia* is set up. This condition is very similar to one which frequently follows spinal injuries, and will be considered with these affections. In other cases, traumatic inflammation of the brain or its membranes may supervene, and will be described in the sequel.

Cerebral irritation.—By cerebral irritation is meant a clinical condition into which a patient occasionally passes after concussion. It seems probable that the peculiar train of symptoms in these cases is due to bruising of the brain, especially of the frontal lobes. The patient, instead of recovering consciousness, lies on his side, curled up. He is restless, constantly turning from side to side, but never extending himself. He is very irritable and objects to being roused, his eyelids are firmly closed and he resists any attempt to open them. The characteristic points about the case, as distinguishing it from an inflammatory condition, are the slowness of the pulse, which sometimes only beats 40 or 50 in a minute, the absence of any heat about the head, and the subnormal temperature, which even when taken in the rectum is only 96° or 97° F. He swallows what is given him, and though he usually passes his urine and fæces in the bed, will occasionally pass his water voluntarily and use the bed-pan. He continues in this condition for a varying period, often for three weeks, and then begins to improve; he stretches himself out and assumes the supine position. His temperature becomes normal and his pulse beats more rapidly, and in most cases he recovers completely; but in some the mind may be affected for a long period or even permanently. The most characteristic feature is the entire loss of memory and absence of knowledge of all that has been going on while the patient has been in this condition.

Treatment.—The treatment of concussion consists mainly in keeping the patient absolutely quiet and free from all external sources of annoyance. He should be placed, if possible, in a darkened room, and protected from all noises or sources of irritation. If the collapse is very great, means must be taken to rally him from it (see page 41), but under ordinary circumstances all that is necessary is to wrap him up in a blanket and put hot-water bottles in his bed. Stimulants should not be given, unless absolutely required, for fear of too great reaction. When reaction comes on, a dose of calomel followed by a saline purge is generally of advantage, and the diet for some days should be fluid. During convalescence all work, and especially mental work, should be avoided, the diet should be light, and all alcoholic stimulants interdicted. In cases of cerebral irritation, very much the same line of treatment is to be followed. The patient is to be kept perfectly quiet, free from external sources of annoyance, interfered with as little as possible, on a fluid diet, with an occasional purge. If there is much restlessness, the administration of bromide of potassium in fifteen-grain doses three or four times a day will probably check it; but if not, no harm seems to arise from combining some chloral hydrate with it, though it is better to avoid its use if possible.

Compression of the brain is that condition where some abnormal intra-cranial pressure interferes with the functions of the brain. This may be either a local compression of one particular part of the nervous tissue or a general compression of the whole central nervous system from a rise of intra-cranial pressure in consequence of the compression of the cerebro-spinal fluid in the sub-arachnoid space. Compression may arise either from injury or disease. The traumatic causes, with which we have at present only to do, are four in number: (1) depressed bone, (2) extravasation of blood, (3) foreign bodies, and (4) effusion of the products of inflammation.

Symptoms.—The symptoms of compression vary within considerable limits according to the situation, extent and nature of the injury. In a typical case they are as follows: the patient lies on his back quite insensible, and from this insensibility he cannot be roused. The pulse is slow, laboured and heaving, except in cases of very severe compression, when it becomes rapid and irregular. The breathing is slow, laboured and stertorous: the stertor arising from paralysis of the muscles of the soft palate. Expiration is often accompanied by a peculiar blowing out of the cheeks from paralysis of the buccinator muscle. In the later stages, as death is approaching, the respiration frequently becomes rapid and irregular. The surface of the body may be cool, but is generally hot and covered with a profuse perspiration. The temperature is at first subnormal, but as the pressure increases it rises, and towards the close of the case there may be hyper-pyrexia. In some instances the temperature is noticed to differ on the two sides of the body, where the pressure is unilateral. The pupils, when the compression is well established, are usually equally dilated and insensible to light, but during the advent of the compression various changes may be noted in them. On that side of the brain to which the compressing agent is applied, the pupil will be found to first of all contract, and then dilate and become fixed, and as the intra-cranial pressure increases and affects the other side, the same changes take place: so that it is not uncommon to find the pupils during the earlier periods of compression of unequal sizes, and by the changes which take place in them the progress of the condition may be noted. The detrusor muscle of the bladder is paralysed and the urine retained, but after the bladder gets full it overflows, because the sphincter is also paralysed. The bowels are usually torpid, but the sphincter ani being paralysed, they may act involuntarily. There is always paralysis, which in traumatic cases usually affects one side of the body at first—the side opposite to that on which the injury is. Later on, as the general intra-cranial pressure increases, the muscles on both sides become paralysed.

The **diagnosis** between concussion and compression is not always easy, because in many cases the one condition merges into the other, and it is often extremely difficult to distinguish the one from the other. The main difference between the two is that in the one, concussion, there is no paralysis; in the other, compression, there is paralysis, but it is often impossible to say whether this condition is present or not. In concussion the muscles are flaccid, and the patient being unconscious they are not moved, and hence they may be thought to be paralysed: but as soon as the patient begins to recover consciousness he moves his muscles, plainly indicating that this is not the case. Even during the unconsciousness of concussion, the absence of paralysis may be ascertained by pinching or pricking a part of the body, when it will be drawn away. The presence of paralysis in compression may be recognised by comparing the tonicity of the muscles on the two sides of the body, which before the paralysis becomes general will be greater on one side than the other: by noting the stertorous breathing, which is due to the paralysis of the muscles of the soft palate; or the puffing out of the cheeks from paralysis of the buccinator. The fixed and dilated condition of the pupils, denoting paralysis of the sphincter of the iris, and retention of urine from paralysis of the detrusor urinæ, are further indications of the presence of compression. A few words require to be said upon the diagnosis of compression of the brain from injury and coma arising from other causes, mainly from alcoholic or narcotic poisoning, or from apoplexy. In the majority of cases there is no difficulty whatever, the presence of some obvious injury to the head at once settling the question; but there still remain a small percentage of cases where a surgeon is called to attend a man suffering from insensibility, in which no history can be obtained, and the question he has to answer is whether the insensibility is due to drink; compression of the brain from some injury; narcotic poisoning; or to apoplexy; uræmic or diabetic coma; or sunstroke &c. Perhaps the most difficult point of all is to determine whether the man is drunk or suffering from some of these other causes, especially as it is quite possible that he may smell of drink and still be suffering from coma. It should therefore be a constant rule among house surgeons and others, with whom the diagnosis of these cases most often rests, never to send away a patient who is admitted in an insensible condition, under the supposition that he is drunk, but retain him for a few hours, when the return of consciousness will usually settle the question. If the insensibility arise from uræmic or diabetic coma, its existence, in the absence of any history of chronic renal disease, may be established by drawing off and examining the urine. The insensibility of narcotic poisoning may be suspected from the pin-point pupils, and lividity of the face; the insensibility from sunstroke or exposure to cold by the state of the weather, and the circumstances under which the patient was found. There only remains then to distinguish these cases from apoplexy, and this is not easy. It can only be done by excluding other causes, and by the fact that the face of the drunkard is flushed and turgid. The age of the patient should also be considered, late life being favourable to brain disease. But after all it is often impossible to diagnose between these two conditions, and the only true test is the test of time.

1. **Compression from depressed fracture.**—When the symptoms of compression come on immediately after the receipt of the accident, the cause of the compression is either depressed fracture or a foreign body, and to distinguish between the two causes is not as a rule difficult. The history of the case and the examination of the wound will generally suffice to differentiate between the two conditions. Of course, if there is no wound, there can be no foreign body, and in these cases it is sometimes difficult to feel the depressed bone through the mass of bruised tissue and extravasated blood. If there is the slightest doubt in the surgeon's mind, he should never hesitate to make an incision in order to settle the question. The treatment has already been alluded to; that is, whether the fracture is simple or compound, to expose and elevate the depressed bone.

2. **Compression from extravasation of blood.**—Effusion of blood is a very common cause of compression of the brain. The blood may be effused in several situations. (*a*) Between the bone and the dura mater (sub-cranial hæmorrhage). (*b*) On the surface of the brain beneath the dura mater (intra-meningeal hæmorrhage). In these cases it may be effused either between the dura mater and arachnoid in the sub-dural space, or between the arachnoid and pia mater, in the sub-arachnoid space; but as a matter of fact the arachnoid membrane is usually torn, and the effusion takes place into both spaces. (*c*) The extravasation of blood may take place into the substance of the brain or the ventricles.

(*a*) **When the blood is extravasated between the bone and the dura mater**, the most common source of hæmorrhage is the middle meningeal artery, and after this the sinuses of the dura mater, and in rare instances the internal carotid artery may be ruptured as it passes through the carotid canal. The cases of the greatest practical importance with which we have especially to deal are those where the blood comes from the middle meningeal artery (fig. 220). In these cases it is the anterior branch of the vessel, as it lies in a groove on the parietal bone, which is commonly torn, the laceration being generally caused by a fissure running across the bone in this situation. On account of the adhesion of the dura mater to the bone and the weak action of the heart, induced by the concussion—for an injury sufficient to cause fracture of the skull and rupture of the artery will certainly produce also concussion of the brain—the blood is poured out very slowly, and therefore there is an appreciable lapse of time between the recovery of sensibility from the concussion and the subsequent insensibility caused by the pressure of the clot of blood on the brain. The history of such a case is as follows: the patient after an injury to the head is picked up insensible; he recovers from this insensibility more or less completely, and after a lapse of time, generally a few hours, but it may be longer, symptoms of compression appear and progressively increase. The patient now becomes profoundly unconscious with stertorous breathing, and if the bleeding has come from the anterior branch of the artery, paralysed on one side of the body. If conjoined with these symptoms there is evidence of an injury over the temporal region on the opposite side of the body to that on which the paralysis is; or if, there being a wound, fissure of the bone in this region can be detected, the evidence is strongly in favour of the case being one of sub-cranial extravasation from rupture of the middle meningeal artery. Having arrived at the conclusion that the case is one of hæmorrhage from this artery, the surgeon should at once proceed to trephine in order to relieve the pressure, for if this is not done the patient will die from the effects of the compression of the brain. The head having been shaved and rendered aseptic, a point is taken $1\frac{1}{2}$ inches above the zygoma, and the same distance behind the external angular process of the frontal bone. This is the point where the pin of the trephine is to be applied, and before the operation is commenced it is advisable to drive a bradawl down to the bone at this spot, so as to mark its position on the bone before the relation of parts is disturbed. A horseshoe-shaped flap of skin, measuring three inches in length and transversely, is now made with its base just above the zygoma, and consisting of all the structures of the scalp down to the pericranium. This flap is reflected and a crucial incision is made in the pericranium, the point of meeting of the four arms being at the mark left on the bone by the bradawl. The flaps are turned back, and the pin of an inch trephine applied to the mark. After the crown of bone has been removed, the blood clot is exposed, and must be gently removed with the scoop of a director, and syringed with weak antiseptic fluid. When the wounded artery is exposed it may cease to bleed, otherwise it must be seized and tied or twisted; or if it lies in the canal in the bone, and this cannot be done, the canal may be plugged with a little carbolised wax. In some cases serious difficulty has been found in stopping the bleeding, and it has been found necessary to tie the external carotid artery.

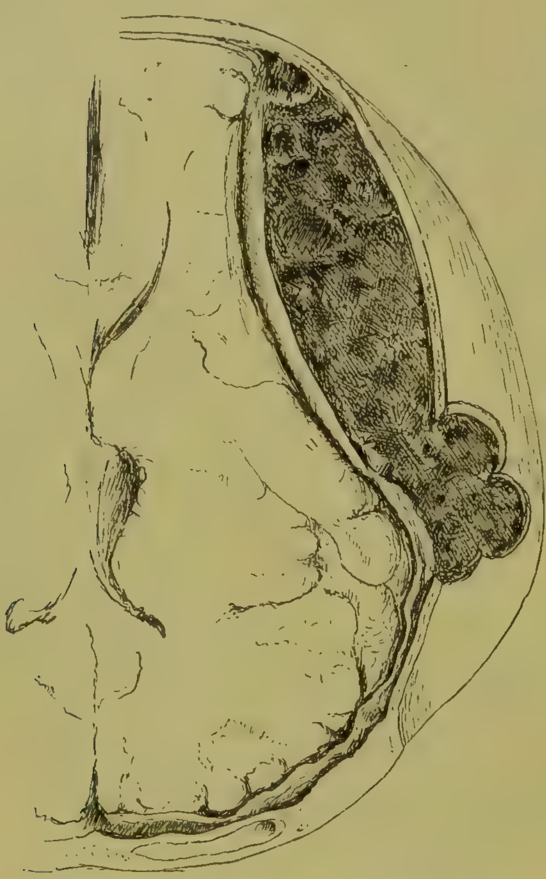


FIG. 220.—Extravasation of blood between the bone and dura mater, from a case of laceration of the middle meningeal artery. (From the Museum of St. George's Hospital.)

(*b*) **Extravasation of blood on the surface of the brain beneath the dura mater** takes place much more rapidly, because there is not the same resistance as there is in the sub-cranial hæmorrhage, and hence the same sequence of events is not observed, and the symptoms of concussion usually merge into those of compression without any intervening period of consciousness. In many of these cases the bleeding comes from the small vessels of the pia mater, and the amount of blood extravasated is not large, and therefore the signs of compression are very slight, or may be altogether absent, the patient after the injury presenting symptoms of apparently very severe concussion from which he does not rally for some time; eventually, however, he may recover, with perhaps signs of some irritation of the brain, as persistent pain, loss of mental power, irritability of temper, or perhaps epileptiform seizures. In these cases the blood clot becomes converted into a cyst, constituting what is termed *blood cyst of the arachnoid* (fig. 221).[1] In severer cases where the blood poured out is greater, the symptoms of compression are well marked; and in these cases the supervention of compression on the top of concussion after a severe injury to the head, without any intervening period of consciousness, would point to the extravasation having taken place either in the sub-dural space or in the substance of the brain. The diagnosis between these two latter conditions cannot be made; but extravasation into the substance of the brain after injury is very rare, except when there is extensive laceration, and then the symptoms of laceration would be superadded to those of pressure, and the case would in all probability be rapidly fatal. In those cases, therefore, where compression comes on *gradually* after concussion, without any recovery of consciousness, there is a fair inference that the extravasation is sub-dural, and the diagnosis may be confirmed by observing that there is paralysis or spasm of a single group of muscles or of one limb, and this observation would serve also to localise the clot. In such a case it would be right to remove a crown of bone with a trephine from that part of the skull where the clot was judged to be; and if, on removing the crown, the dura mater bulged up into the hole, and no pulsations were visible, to incise the dura mater. If blood clot is found, it must be gently removed and the cavity syringed out, and any bleeding points secured and tied if possible; or if not, plugged with antiseptic gauze.

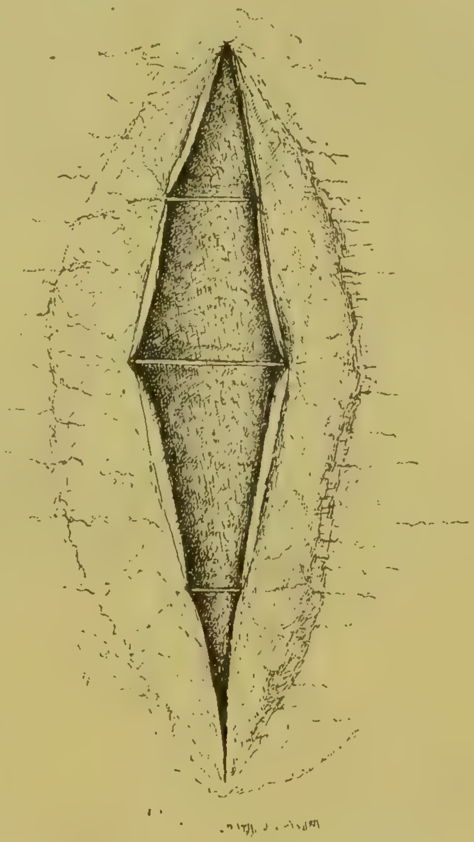


FIG. 221.—Blood cyst of the arachnoid. (From the Museum of St. George's Hospital.)

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[1] The manner in which these cysts are formed has been referred to on page 49.

(*c*) **Extravasation into the substance of the brain or into the ventricles** is, as we have already stated, very rare as the result of an injury to the head, except in cases of severe laceration, though the condition is common enough when arising from idiopathic causes. This condition will therefore be considered with that of Laceration of the Brain.

Contusion and **laceration of the brain** is of frequent occurrence in injuries of the head, and the amount of injury may vary very considerably from slight bruising of the brain substance to extensive laceration and disintegration. We shall first of all consider those cases where the bruising and laceration occur without any external wound, and then those in which there is an external wound, and the laceration is produced by some foreign body introduced from without, making, in fact, the same distinction as between contusions and wounds on the surface of the body.

1. **Bruising and laceration without wound.**—These are produced by severe injuries to the head, with or without fracture of the skull. In some the laceration may be produced by a simple depressed fracture; in others there may be a fissure of the skull, and in a large number there is no solution of continuity of the bones. In these latter cases, in the majority of instances the laceration of the brain takes place at the part opposite to the point struck; as, for example, in the case of a man falling and striking the back of his head, the laceration of the brain is in the frontal lobes. This is caused by a wave of the soft brain substance, which starts from the site of the injury; traverses the brain substance, and impinges on the bone opposite to the point struck, and in this way causes the laceration in this situation.

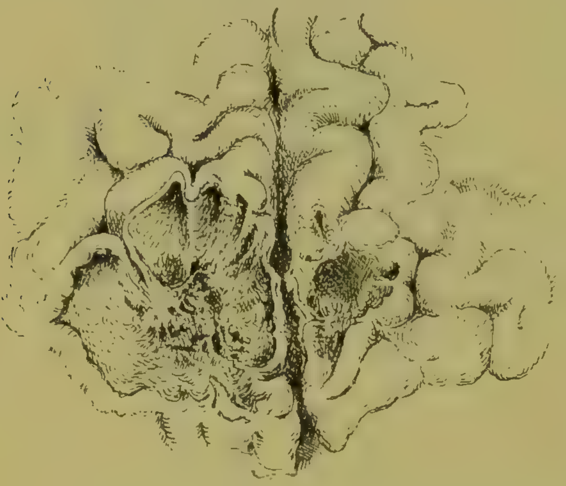

FIG. 222.—Laceration of the frontal lobe of the brain. (From the Museum of St. George's Hospital.)

Pathological anatomy.—The appearances found after death vary with the extent of the lesion and the period of time after the accident at which death has taken place. If this occurs shortly after the accident, all degrees of injury may be met with; there may be a little superficial bruising, a few spots of ecchymosis scattered through the grey matter at one particular point; or there may be extensive laceration and breaking down of the tissue on the surface of the brain at one part (fig. 222), and this may or may not have been accompanied by a considerable outpouring of blood, which may be diffused far and wide in the sub-arachnoid space, or may form a large clot in the neighbourhood of the injury. In still severer cases the laceration may have extended deeply into the substance of the white matter, and may even have extended into the ventricles, which will then be found to be full of blood. The brain substance around the laceration, whether great or small, will be found disintegrated, infiltrated with blood and reduced to a pulpy mass (fig. 223). If the patient survives for some time and then dies, and the brain is examined, a peculiar condition which is known under the name of *yellow softening* will be found in the brain matter around the laceration. This condition is due to a disintegration and liquefaction of the brain substance by means of fatty degeneration from obstruction and arrest of the circulation. The appearance of the parts as now seen is a broken-down mass of blood clot of a black or brownish hue, surrounded by a halo of yellowish pulpy material, which breaks down and is washed away by a stream of water. If a section is made at the margin of this softened part, where the process is going on, and is examined under the microscope, groups of fat granules can be seen aggregating themselves between the nerve fibres ; in a more advanced stage nothing is to be seen but broken-down débris with fat granules and granular cells suspended in the fluid products of softening.

Death in cases of laceration of the brain may occur in several ways : (1) from the effects of compression of the brain, i.e. cessation of respiration : (2) from spreading œdema leading to general cerebral pressure and death. The formation of this spreading œdema is explained in the following way. The blood extravasated around the laceration presses on the veins of the pia mater, and thus causes obstruction to the return of venous blood. This sets up a passive congestion in an area around the laceration, and the watery constituents of the blood filter through the coats of the capillaries and produce œdema. When this has once commenced, it may progressively increase, since the venous circulation in the œdematous area becomes in its turn interfered with. This goes on until sufficient exudation has taken place to produce fatal compression of the brain ; (3) death may be caused later on in case of laceration of the brain from the effects of yellow softening, especially if the softening extends to vital parts of the brain ; or (4) encephalitis may be set up, which may lead to the formation of a local abscess or to diffuse suppuration.

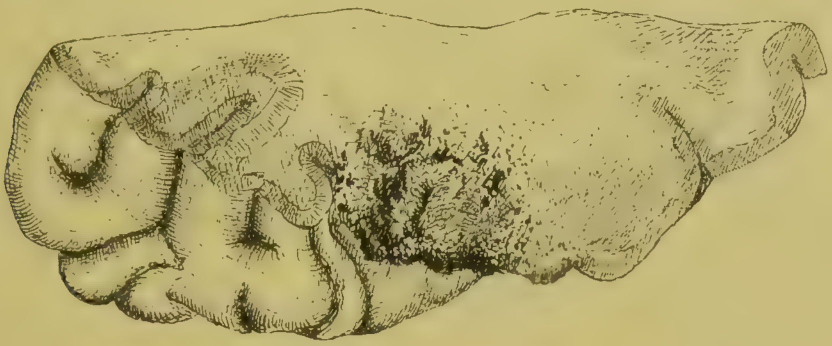

FIG. 223.—Contusion and laceration of the cortex of the brain. (From the Museum of St. George's Hospital.)

Symptoms.—The symptoms of contusion and laceration of the brain are mixed up with those of concussion ; for an injury sufficiently great to cause contusion or laceration of the brain must have been severe enough to produce concussion. In addition to this there is no sharp line of demarcation between concussion and contusion, for in all cases of concussion when the patient is slow in recovering consciousness there has probably been some contusion or it may be laceration of the brain ; and in those severer cases which were described above as cases of cerebral irritation (page 592) there seems no reason to doubt that the peculiar train of symptoms is due to severe contusion or bruising of the brain, with or without laceration. Again, on the other hand, the symptoms of contusion and laceration are intimately mixed up with compression. If a patient after an injury to the head suffers from concussion, which merges into compression, we have evidence of extravasation of blood somewhere into the cranial cavity. If there has been an interval of consciousness between the concussion and the compression, it is probably outside the dura mater; if there has been no interval of consciousness, it is inside the dura mater, and is due either to extravasation on the surface of the brain or to laceration of the brain substance. The diagnosis between these two conditions has already been alluded to.

The most important sign of laceration of the brain is convulsions. A violent attack of convulsions occurring within twelve hours of an injury to the head is pathognomonic of laceration, but convulsions or even rigidity or paralysis of groups of muscles coming on within the fifth day after the receipt of the injury points strongly in this direction. Of course, these convulsions are only present when the lesion implicates the cortical motor area. When this area is not implicated the only symptoms would be gradually increasing insensibility; but this might also be caused by diffuse extravasation on to the surface of the brain, which might take place without laceration. When the convulsions are accompanied by gradually increasing paralysis, the paralysis having been found to spread after each convulsion, the laceration is probably extensive and the case a serious one; but in those cases when the fits are not accompanied by gradually increasing paralysis, and the patient recovers consciousness between them, they will probably cease after a time and the patient recover.

Treatment.—The treatment of laceration of the brain without any external wound consists in keeping the patient absolutely quiet, applying ice to the head, and administering a purgative in the early stage. If there is any depressed bone it must of course be elevated, but otherwise the symptoms are not as a rule sufficiently definite to enable the surgeon to localise the situation of the injury. After paralysis is set up, it may be possible to indicate the seat of the lesion, and then trephining should be resorted to over the injured area. When the convulsions become more violent and the paralysis increases, and the patient more and more insensible, the question of operative interference is a very serious one. The increase in the symptoms may be due to inflammation around the extravasation, and this will be indicated by heat of the head and a rise in the temperature, and probably under these circumstances no good would be done by trephining. The treatment should rather consist in shaving the head, and applying leeches and afterwards ice; in freely purging the patient, and keeping him on a low diet, principally milk. Bromide of potassium in full doses sometimes has the effect of lessening the convulsions. In those cases where the increase of the symptoms is not attended by any signs of inflammation, it is probably due to spreading œdema, and under these circumstances trephining should be resorted to if the mischief can be localised, as the relief of pressure, by removing the blood clot and exuded fluid, may be the means of arresting the further progress of the disease.

2. **Bruising and laceration of the brain with an external wound.**—Wounds of the brain or its membranes may be produced by fragments of bone being driven into it in cases of compound depressed fracture; by stabs or sabre cuts; by thrusts through the orbit

or nose with sharp-pointed instruments, as a knife or pair of scissors, or with blunt instruments, as a stick or umbrella; and finally by bullets in gunshot wounds.

Symptoms.—The local signs are sufficiently obvious: there is a wound, at the bottom of which the dura mater can be seen to be injured, and from which in many cases brain matter may be escaping. The general symptoms may be very slight, for there may be a severe injury to the brain, especially to the frontal lobes, and still the patient may be perfectly conscious. The bleeding which takes place in a considerable majority of cases can escape by the wound, and therefore does not exert any pressure on the brain substance, except in those cases where the ventricles have been opened and the bleeding takes place into them; or in others, where the bleeding takes place into the substance of the brain, from not being able to find an exit through the external wound. Under these circumstances fatal compression would ensue. In some instances, especially in gunshot wounds, sudden death may occur: the explanation of this phenomenon depends upon what is called the *hydrodynamic effect* of the bullet, and is due to the momentum of the missile being transferred to the molecules of the brain substance, and causing waves of increased pressure, which reach the base of the brain, and cause arrest of the respiration by the effect they produce on the medulla.

The great danger of wounds of the brain is septic meningo-encephalitis, which will be described immediately. If the wound is rendered and maintained aseptic, probably there is less danger than from a laceration of the brain without wound, since the dangers of compression from effused blood or from spreading œdema are lessened by the escape of blood from the wound.

Treatment.—In all cases of compound fracture of the skull in which the brain or its membranes have been injured, a thorough exploration should be made, unless the patient is obviously sinking from the injury. The hair should be cut away from around the wound; indeed, in most cases it is better to shave the whole head, and the scalp should be cleaned and rendered aseptic. The wounded part should be then explored if necessary by enlarging the wound and removing bone with the trephine or Hey's saw. Any depressed bone must be elevated, and any loose fragments removed. If the injury is due to a gunshot wound, the bullet should be removed if it can be easily found, but no prolonged search should be made. The Röntgen rays will often be of service in the diagnosis and localisation of bullets lodged within the brain, but a long exposure must be given owing to the opacity of the cranium. The whole wound is then scrupulously purified with carbolic lotion (1 in 20). If the dura mater has not been much lacerated and torn, the wound in it should be brought together with sutures and a drain of iodoform gauze inserted through it. The external wound should then be closed with sutures and dressed. If all goes well and the temperature remains normal, the gauze drain may be safely removed on the second day and the wound redressed. Should, however, the temperature rise and signs of inflammation appear about the wound, it must be reopened, so as to relieve tension, and localise as far as possible the mischief.

Traumatic meningitis and encephalitis. Meningitis and encephalitis are so inseparably associated that they cannot be diagnosed from each other, and though the inflammation may, and doubtless does, begin in the membranes primarily in most instances, still the brain substance very speedily becomes involved by an extension of the inflammatory process to it. The two conditions will therefore be considered together. With the exception of the slight local inflammation which must necessarily follow all wounds and lacerations of the brain, but which shows no tendency to spread, it is probable that all inflammatory conditions of the brain or its membranes, following injury, are due to the introduction of micro-organisms, whether there is an external wound or not. In cases where there is an external wound, as in punctured wounds, compound fractures of the vault, or fractures of the base, the septic organisms gain access to the brain and its membranes by a direct route; but where these conditions do not exist, the micro-organisms may still gain access by an indirect route, and under these circumstances the advent of the symptoms is often much delayed. The means by which they gain an entrance may be either through the veins, from thrombi spreading inwards through the diploic or emissary veins to the venous sinuses and so to the brain, or through the lymphatics to the outer surface of the dura mater. It is said also that septic matter may find its way along a nerve to the membranes; this is probably by extension along the perineural lymphatics which open into the sub-arachnoid space.

Inflammation of the brain and its membranes usually makes its appearance on the second or third day after the injury when there is an open wound, so that the septic organisms are conveyed directly to the membranes; but in those cases where there is no wound, and the septic matter has to be conveyed by an indirect route, the advent of the symptoms may be delayed to the second or third week or even longer.

Pathology.—Upon examining the brain of a patient who has died of acute septic meningo-encephalitis, the surface of the brain, especially in the neighbourhood of the injury, will be found to be covered with a greenish yellow lymph, which may sometimes be almost purulent in character. The pia mater will be intensely injected and often ecchymosed. The convolutions of the brain will be flattened: the grey matter of the cortex of a darker colour than natural, and the white matter presenting an increased number of punctæ vasculosæ. The ventricles are usually full of fluid, which is often turbid and coagulates on boiling. The central parts of the brain are softened, and wash away with a gentle stream of water.

Symptoms.—The disease is usually ushered in by severe pain in the head, with a rise of temperature. The patient may complain of alternate feelings of heat and cold, or there may be a distinct rigor. There is often vomiting. There is frequently intolerance of light and of noise, and the head feels hot. Combined with the rise of temperature, which speedily reaches 102° F. or 103° F., there are the usual phenomena of a febrile condition, a hot skin, furred tongue, and a rapid, full and bounding pulse.

These symptoms pass on in the course of a few hours to extreme restlessness and delirium. There are also frequently convulsions, especially when the convex surface of the brain is most involved. They may be limited to a single group of muscles, or one side of the body may be affected, or there may be general convulsions. Where the inflammation principally affects the base, the head may be retracted from rigidity of the extensor muscles, and optic neuritis may be present. After a time, generally measured by hours, the delirium is replaced by stupor, and paralysis comes on, at first affecting a group of muscles, then often one side of the body, and finally becomes general. The stupor merges into coma; the breathing becomes stertorous; the respirations become irregular, and death takes place by a cessation of respiration.

Diagnosis.—These cases must not be mistaken for spreading œdema of the brain (page 599). In cases of injury to the head, with concussion, the patient may become comatose on the second or third day and may die. These are sometimes regarded as cases of acute encephalitis, but are probably spreading œdema. The distinction between the two conditions is not easy to make, but in the spreading œdema there is not the same fever, with rise of temperature, heat of scalp, and full bounding pulse.

Treatment.—The treatment of this condition is mainly preventive, by maintaining strict asepticity, for it is probable that when the disease is thoroughly established recovery is almost hopeless. The head should be shaved, and ice constantly applied. If the patient is young and strong, it is advisable to perform venesection, or apply leeches to the head. The patient should be kept absolutely quiet in a darkened room, and allowed nothing but a little milk occasionally. Calomel should be given in grain doses every two hours, until the gums are affected. When coma comes on, the question of trephining and draining the sub-arachnoid space has to be considered. By relieving pressure, the patient is perhaps put in a better position to combat the septic condition, but the operation must be regarded as an almost hopeless one.

Sub-acute meningo-encephalitis.—Many cases of the sub-acute form of the disease are really conditions in which the septic matter has found its way to the membranes by an indirect route, and where therefore the advent of the disease has been delayed, and for this reason they have been regarded as a sub-acute form, but they are in fact acute enough in their course when once established. But in addition to these, there are cases where the patient after an injury to the head does not appear to recover completely; he is constantly ailing, complains of persistent headache, of impairment of sight and hearing. There is often irritability of temper and loss of mental power. The onset of more acute symptoms may be gradual or sudden, and is sometimes ushered in by an epileptic fit. The pain in the head now becomes more severe, there is heat of the scalp, intolerance of light; the patient is restless, tossing himself about, moaning or screaming. There is often convulsive twitching of the limbs and face, with symptomatic fever. Gradually symptoms of compression come on, and the patient becomes comatose and dies. After death the whole of the surface of the brain may be found to be obscured by a thick layer of greenish yellow lymph, the substance of the brain softened and the ventricles full of turbid fluid.

Treatment.—The treatment consists in absolute rest and quiet; counter irritation to the nape of the neck; mercury in small, frequently repeated doses, and the bromides of potassium and ammonium to soothe the patient and procure sleep.

Intra-cranial suppuration.—Abscesses within the cranium are probably caused by the introduction of micro-organisms, even in those cases where the abscess forms in the brain substance opposite the point struck. There has probably been a bruise of the brain in this situation from *contre-coup*, and the injured part has become infected with organisms circulating in the blood. In most cases the organisms effect a direct entrance through a wound, most commonly a punctured wound, but occasionally abscess occurs at the site of the injury, where there is no fracture in the skull: under these circumstances septic phlebitis occurs in the diploë, and the infective process spreads inwards along the vessels.

Intra-cranial abscess may occur in three situations: (1) between the bone and the dura mater; (2) between the membranes; and (3) in the brain substance.

1. **Abscess between the bone and the dura mater.** (*Sub-cranial.*) -These cases have already been described (page 582).

2. **Intra-meningeal abscess.**—Abscess between the meninges generally occurs when the bone is fractured and the dura mater torn, so that the organisms find direct access to the sub-dural space, and there set up a localised suppuration. Sometimes it is merely an extension of suppuration from between the bone and dura mater. The symptoms are those of meningitis, followed by compression.

3. **Abscess in the brain substance** may be acute or chronic. The **acute** abscess is usually the accompaniment of the two preceding varieties, sub-cranial and intra-meningeal abscesses. It is situated close to the surface of the brain, opposite the point of injury, and is caused by the direct extension of the inflammatory process. The symptoms are therefore the same, viz. those of septic inflammation followed by drowsiness, deepening into insensibility and coma.

The **chronic** abscess is usually situated more deeply in the white matter. Its exact mode of formation is not quite certain. It usually occurs in cases of scalp wound exposing the bone, with or without fracture, and is usually believed to be due to a septic thrombosis extending from the injured spot into the brain substance.

Symptoms.—The symptoms are the same as those arising from abscess of the brain produced by suppuration in the middle ear: namely, pain; vomiting; slow pulse and sub-normal temperature; possibly a dilated pupil on the affected side, and optic neuritis; sluggish cerebration followed by drowsiness, deepening into coma. In addition to this there may be certain localising symptoms which will be referred to in the sequel (see Cerebral Topography).

Treatment.—The only treatment for intra-cranial suppuration is the treatment of abscess in other parts of the body—evacuation of the pus. In acute abscess the bone must be trephined if no opening exists in it from fracture, and if there is it will probably require enlarging; the dura mater must be freely incised and the pus let out. The cavity must be gently syringed with antiseptic fluid and a drainage tube inserted. This gives the patient his only chance; but if the disease is complicated with septic meningitis, the prospect of recovery is small. In chronic abscess the treatment is the same. If the symptoms detailed above are present, the bone must be exposed over the seat of the injury, if it is not already exposed by the accident. If the bone is white and dry, it will indicate that the suppuration is sub-cranial (see page 583); but whether it is so or not, the bone must be trephined. If the abscess is situated deeply in the brain substance, the dura mater may be apparently quite healthy, but will probably bulge more than natural in the trephine hole. There may or may not be pulsation of the brain visible. Whether the dura mater is healthy or not, a small incision should be made in it to ascertain whether the pus is intra-meningeal. If no pus is found, an exploring director should be pushed directly into the brain substance in the direction in which the abscess is believed to exist. If a drop of pus appears, a narrow knife must be passed along the director and the pus evacuated. When the abscess is emptied, a drainage tube must be inserted, otherwise the soft cerebral matter will close the opening. If pus is not found at the first exploration, several punctures may be made in different directions.

Hernia cerebri.—In cases of fracture of the skull where the dura mater has been injured, and after trephining where the dura mater has been incised, a swelling is liable to appear at the seat of lesion, due to a protrusion of the brain substance, which is called a *hernia* or *fungus cerebri.* It differs under different circumstances. After the operation of trephining, if the wound is maintained aseptic, it is probably due to non-inflammatory œdema. The wound of the operation may have entirely healed, when a swelling appears under it, which is soft and pulsates synchronously with the brain. The mental condition of the patient is probably not disturbed. Where, however, there is an open wound, as after a compound depressed fracture, some time after the injury, varying from days to weeks, a dark brown or blackish fungous protrusion may appear at the wound and increase rapidly (fig. 224). It consists of softened brain matter, infiltrated with inflammatory exudation and blood, and is caused by increased intra-cranial pressure pushing out the softened brain matter. This mass pulsates synchronously with the brain. In some instances no brain matter is contained in the protrusion, which consists simply of extravasated blood, which has been effused on the surface of the brain. It is then known as a *false hernia cerebri.* Where this septic condition exists, a diffuse encephalitis generally starts from the base of the tumour and ends in stupor, coma, and death.

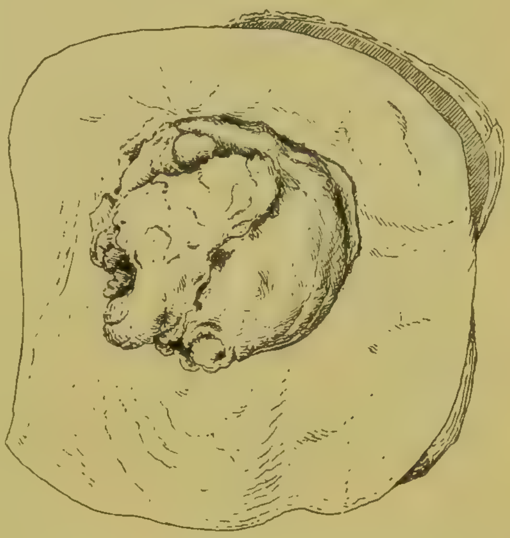

FIG. 224.—Hernia of the brain. (From the Museum of St. George's Hospital.)

Treatment.—In the operation of trephining, care should be taken to prevent the occurrence of hernia cerebri by replacing the bone which has been removed, in the manner which will be alluded to in describing the operation. Should, however, the hernia occur, it must be protected and prevented from getting larger by pressure. This is best done by moulding a cap made of sheet lead accurately to the swelling and keeping it constantly applied. If the fungous protrusion forms in an open wound, the treatment is unsatisfactory. The hernia should be shaved off level with the surface of the skull and the part dressed antiseptically, firm pressure being made to prevent, if possible, further protrusion.

Remote effects of injuries of the head.—Injuries of the head must always be regarded as serious, for in addition to the immediate danger, in a considerable number of cases some morbid condition is left, after the patient has apparently recovered from the immediate effects, which may prove to be of the gravest importance. One condition has already been spoken of in dealing with concussion, as traumatic neurasthenia; but many other conditions, such as insanity, epilepsy, diabetes, where the injury implicates the floor of the fourth ventricle, impairment of one of the special senses and paralysis, may follow injuries of the head, after the patient has apparently recovered from the direct effects of the injury. In addition to these grosser lesions, the symptoms of which are well marked, the patient may for a long time after an injury show a peculiar condition of brain which evidences itself by alterations in temper, violent paroxysms of passion, and often apparently uncontrollable actions, especially after any mental exertion or after taking alcohol even in limited quantities. At other times he is unable to fix his attention on any subject or to pursue a continuous train of thought. These patients often die suddenly, it may be some years after the original injury.

Epilepsy is the only one of these conditions which requires special mention, as it is the one which the surgeon is most often called upon to treat. The epilepsy in these cases is of a somewhat different kind to ordinary idiopathic epilepsy and is known as 'Jacksonian epilepsy.' The attack begins by a peculiar sensation in some part of the body, followed by a twitching of the muscles of the part; from this starting point the sensation and the twitchings gradually advance to other parts in a definite order, until the attack may culminate in a general convulsion. There is often no loss of consciousness. This condition, according to Dr. Hughlings Jackson, can only occur where there is some lesion of the convolutions in the neighbourhood of the fissure of Rolando. It may arise from several different causes: (1) from scars or lesions in the cerebral cortex; (2) from thickening of the membranes or the presence of a cyst caused by extravasated blood beneath the dura mater; (3) from sclerosis of the bones of the skull after injury; (4) from a depressed spicula of bone pressing on the brain: or (5) from a neuralgic cicatrix on the scalp, causing reflex convulsions

Treatment.—If the disease is apparently due to a painful cicatrix, it should be freely excised. In other cases trephining should be resorted to, the position for the application of the trephine being indicated by the history of the accident, by perhaps the presence of a scar or a piece of depressed bone which can be felt, and by a careful observation of the attacks, noticing the position where the convulsive movements commence, as they always begin in the part in connection with the affected centre. The results of the operation are not always so satisfactory as might have been expected, even in those cases where the cause of the epilepsy has been removed. In the majority of cases it would appear that the operation fails to cure the epilepsy; the treatment, therefore, of this condition must be regarded as mainly preventive, and is an additional argument, as Professor Agnew has pointed out, in favour of always elevating a depressed fracture.

Cerebral topography.—As will be seen from the foregoing pages, trephining is required for a number of different conditions, such as depressed fracture or lodgment of foreign bodies; cases of localised pressure from extravasated blood; cases of intra-cranial suppuration where the symptoms indicate that the pressure is localised; and for epilepsy and other later results of a cranial injury. But nothing has been said upon cerebral localisation in reference to these conditions. Of course, in some cases there is no difficulty in determining the position in which to apply the trephine, as, for instance, in a case of depressed fracture where the depression can be felt; but in others we have to be guided by the symptoms which the patient presents. Until recently we had no means by which we could exactly define the part of the brain which was injured in very many cases, but recent physiological and pathological researches have rendered it almost certain that the surface of the brain may be mapped out into a series of topographical areas, each of which is intimately connected with some well-defined function. Although the functions of many of these areas is unknown, yet there are others where the function can be stated with considerable accuracy.

The principal of these is that known as the Rolandic or motor area, because it is that part of the cortex in which lesions cause paralysis on the opposite side of the body. It may be said to include a parallelogram about an inch wide, drawn in such a manner that the fissure of Rolando passes obliquely from the posterior superior to the anterior inferior angle. Its limits will be seen by referring to fig. 225. In this figure the various subdivisions marked out indicate the different parts of the cortex which are believed to preside over the muscles of different regions of the body, and indicate the position in which the trephine should be applied, where there is irritation or paralysis of the muscles of that region. In many instances lesions are combined; under these circumstances the trephine must be applied to points intermediate between the respective centres.

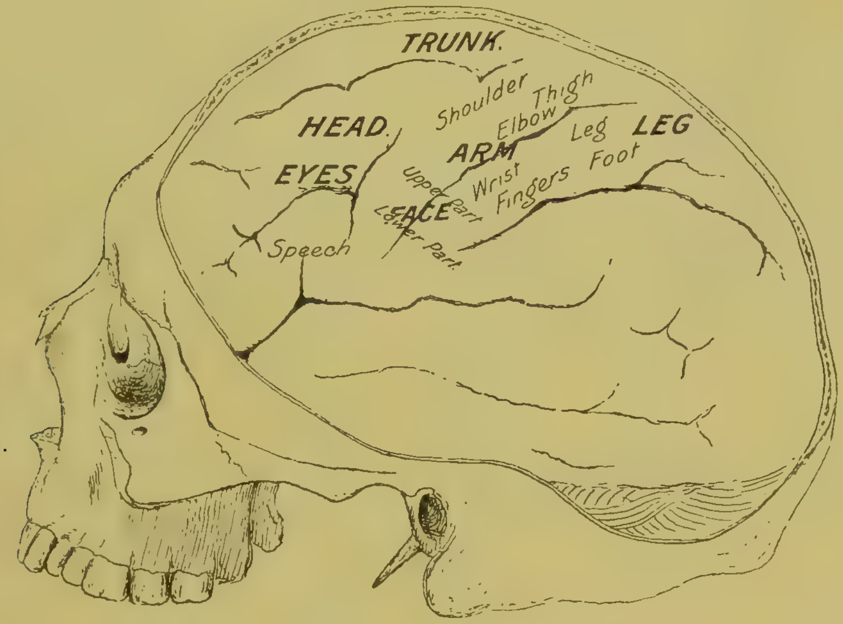

FIG. 225.—Topography of the motor area of the brain.

Other parts of the convolutions, the functions of which are sufficiently well localised, are the temporo-sphenoidal lobe and the occipital lobe. The upper temporo-sphenoidal lobe contains the auditory centre, and lesions in this situation cause deafness. The deafness is not, however, complete unless there is a lesion of both hemispheres; hence it is assumed that each ear is connected with both hemispheres. The occipital lobe is the seat of the function of vision. Lesions of this lobe on both sides produce complete blindness; lesion on one side only produces hemianopsia, blindness of one half of the retina in each eye.

In connection with the centre of speech which lies at the lower and anterior angle of the motor area (fig. 225), it should be noted that it is situated in the left hemisphere only in right-handed individuals, and the right only in left-handed people. Lesion of this particular convolution destroys the ability to express ideas correctly in words: lesion of the same convolution on the opposite side has no effect. If motor aphasia, as it is called, is produced by a lesion on the side on which the centre of speech is situated, after a time the same centre on the opposite side appears to have the power of taking on the function of the damaged area. Agraphia, or the inability to write, is generally also present in cases of lesions producing motor aphasia, but the exact site of the centre for this function is not known.

The functions of the other parts of the brain are not so well localised, but sufficient knowledge has been obtained in recent years to enable the surgeon to deal with head injuries and growths in the brain with much more exactness than was the case formerly; but in order to do this it is necessary that he should carefully consider the various landmarks on the surface of the skull, by which he can with a fair degree of accuracy mark out the position of the various convolutions of the cortex, in order that he may deal with them by operation. The most important parts which he has to define are the fissure of Rolando, the fissure of Sylvius, the parieto-occipital fissure and the lower margin of the cerebrum (fig. 226).

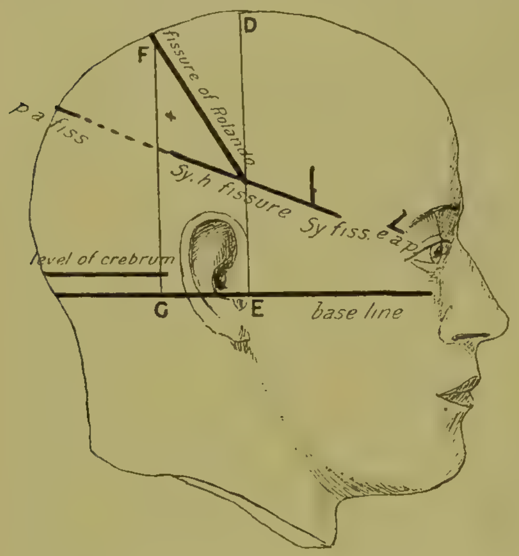

FIG. 226.—Diagram showing the relations of the fissures of the brain to the surface of the skull. (After Reid.)

The fissure of Rolando. In order to define this fissure, its upper extremity must be first found. This is situated in the sagittal suture, at a point 55·6 per cent. of the distance between the glabella and the external occipital protuberance. For all practical purposes the plan suggested by Professor Thane is sufficient. He takes the middle point of the line between the glabella and external occipital protuberance, and fixes the commencement of the fissure at half an inch behind this point. From this the fissure runs downwards and forwards at an angle of 67° with the middle line for about $3\frac{3}{8}$ inches.

Various plans have been devised for marking out the angle, but perhaps the simplest and the one most easily available is to take a square piece of writing paper, one side of which is to be applied to the middle line of the skull, so that its posterior extremity is at Thane's point; the paper is now to be folded over into a triangle, when the folded margin of the paper will form an angle of 45° with the middle line of the skull. By repeating the folding process and bisecting the angle of 45°, an angle of 67·5° is obtained, and the folded margin of the paper would now almost correspond to the fissure. Reid has devised a more exact plan for mapping out the fissure. The keystone to this is a 'base line,' which is a very convenient line from which to take measurements of the skull. It consists in drawing a straight line backwards from the lower margin of the orbit through the centre of the external auditory meatus. This reaches the middle line behind, a little below the external occipital protuberance. Two perpendicular lines are drawn from the base line to the top of the head; one (D, E, fig. 226) from the depression in front of the external auditory meatus, and the other (F, G, fig. 226) from the posterior border of the mastoid process at its root. A line drawn from the upper extremity of the posterior perpendicular line to the point where the fissure of Sylvius crosses the anterior one (see below) would indicate the position of the fissure of Rolando.

The fissure of Sylvius.—The position of the fissure of Sylvius and its horizontal limb is indicated by a line drawn from a point $1\frac{1}{4}$ inch behind the external angular process to one three-quarters of an inch below the most prominent part of the parietal eminence. The first three-quarters of an inch of this line represents the main fissure, and a line drawn upwards from this point represents the vertical portion of the fissure.

The **parieto-occipital fissure** runs outwards at right angles to the sagittal suture, from just in front of the posterior fontanelle, for about an inch. Reid states that if the horizontal limb of the fissure of Sylvius is continued to the sagittal suture, the last inch will indicate, with a fair amount of accuracy, the position of the suture.

The **lower margin of the cerebrum** is indicated by drawing a line from a point half an inch above the external occipital protuberance to a point half an inch above the centre of the external auditory meatus.

Operation of trephining.—Much of the success which has in recent years attended the operation of trephining is due to the preservation of strict asepsis; the surgeon, therefore, who undertakes these operations should be most careful in carrying out antiseptic treatment in all its details. The head of the patient should be shaved and well scrubbed with soft soap and a brush, rubbed with turpentine or ether, and after being sluiced with strong corrosive sublimate or carbolic acid lotion, should, if possible, be covered for twelve hours with a compress of antiseptic gauze wrung out in antiseptic fluid. The best anæsthetic is either chloroform or A.C.E. mixture, as these cause less venous engorgement than ether; and Horsley has recommended a hypodermic injection of morphia before the anæsthetic is commenced, as it tends to cause a contraction of the arterioles of the brain and thus diminish hæmorrhage. Where there is no wound, the skull is best exposed by a horseshoe-shaped incision. Most surgeons recommend that the incision should be carried down to the bone, and the pericranium raised with the flaps by means of a periosteum elevator; but others prefer first to raise the flap from the pericranium, and afterwards this membrane by a crucial incision. Before the incision is made, the operator must have carefully determined by measurement the position at which he proposes to open the skull, and he should mark this spot by driving a bradawl through the skin into the bone, at the point at which he intends to introduce the pin of the trephine. When the pericranium is removed, this mark on the bone will at once enable him to proceed with the operation without delay. The trephine is now to be applied. One worked by the hand is generally employed, but when large surfaces of bone have to be removed, a circular saw, driven by an electro-motor, is sometimes used. It possesses, in addition to the speed with which it can be worked, the advantage that it exerts no injurious pressure on the skull. The size of the trephine varies according to the case for which it is used, but it is always well to employ one sufficiently large. A trephine with a diameter of from two to three inches is generally the most convenient. As soon as the crown of bone has been removed, it should be placed in a normal saline solution at a temperature of 105° F., and the temperature should be maintained at this point. This is to allow of its being replaced after the operation is over. If this is done it will retain its vitality and become adherent to surrounding parts, sometimes by bony union (fig. 227). Of recent years, Wagner and other surgeons have adopted a different plan in opening the skull, with the object of replacing the portion of bone removed. Instead of trephining after the horseshoe-shaped incision has been made, the soft parts are not reflected from the bone, but a gutter is cut in it, following the line of incision in the scalp, by means of a small gouge. The piece of bone is prised up by an elevator, the base of the bony flap is broken, and adhering to the scalp, is turned up with it. The operation is a tedious one, and the force necessary to gouge through the bone must be injurious to the structures beneath, which are also in much danger of being injured by a slip of the gouge. After the crown of bone has been removed, if sufficient room has not been obtained, a second crown must be taken out, and the triangular pieces of bone between the two removed with a saw or chisel; or the opening in the bone may be enlarged by Hoffman's gouge forceps.

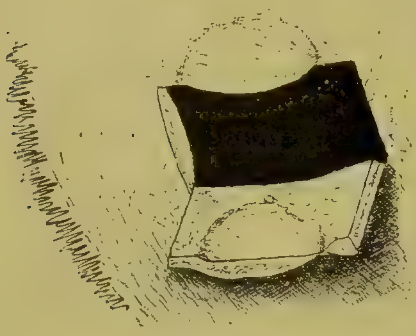

FIG. 227.—Drawing showing the bony union of the crown of bone removed in trephining. (From the Museum of St. George's Hospital.)

If the dura mater requires incising, it should be opened with the point of a scalpel about a quarter of an inch internal to the hole in the bone, and then divided with blunt scissors for two-thirds of the extent of the line of the opening in the bone.

The brain, having been exposed, must be examined as to bulging, pulsation, resistance, and colour. If it bulges into the trephine hole, it is an indication of increased intra-cranial tension; if it does not pulsate, it is also an indication of intra-cranial tension; if the bulging, non-pulsating brain feels on palpation softer than normal, the presence of fluid beneath would be suspected, and an exploring director should be introduced to verify this. If, on the other hand, it feels harder and firmer than natural, a new growth or chronic inflammatory induration would be indicated. Sometimes an alteration in colour may be noticed, and if it presents a yellowish tinge, this would, according to Horsley, indicate a sub-cortical tumour.

After the operation is complete, the dura mater is sutured in position, and the bone replaced. Some surgeons recommend, before doing this, to cut it up into small pieces and place these on the surface of the dura mater; but there seems no object in doing so. The scalp flap is then laid down and accurately adjusted with sutures, and the wound dressed.

Injury of the cerebral nerves.—Before concluding the subject of injuries of the head, it is necessary to say a few words on injury to the cerebral nerves. These nerves may be injured in a variety of ways, of which perhaps the most common is when they are torn across in fissured fractures of the base of the skull, where the fissure extends across the canal or foramen in which they are lodged. They may also be cut across by a bullet traversing the base of the skull, or they may be torn from their connection with the brain in cases of laceration.

The **olfactory** nerve is not infrequently injured in fractures of the anterior fossa of the base of the skull involving the cribriform plate; or the nerve may be severely contused in injuries of the anterior lobes of the brain, where there is no fracture. In these cases loss of smell (anosmia) is the result. The **optic** nerve may also be injured in those cases of fracture of the anterior fossa of the base of the skull which involve the lesser wing of the sphenoid and extend into the optic foramen. It may also be torn across in thrust wounds of the orbit, or may be compressed by hæmorrhage or inflammatory exudation. These injuries are accompanied by loss of sight. The **third, fourth,** and **sixth** nerves may be injured either as they lie in the cavernous sinus, or as they pass through the sphenoidal fissure in fracture of the base of the skull; or they may be torn in cases of penetrating wounds of the orbit, or blows causing laceration of its contents. If the third nerve is paralysed, there will be ptosis or drooping of the eyelid; external strabismus, from the unbalanced action of the external rectus, owing to paralysis of the internal rectus; and dilatation of the pupil, from paralysis of the sphincter fibres of the iris. There will also be loss of accommodation from palsy of the ciliary muscle, and slight prominence of the eyeball owing to most of its muscles being relaxed. If the function of the fourth nerve is destroyed, the superior oblique muscle is paralysed, so that the patient is unable to turn his eye downwards and outwards. If the patient attempts to do this, the eye is turned inwards, producing double vision; hence giddiness is produced if the patient goes down stairs or down a hill, from the double vision induced by the patient looking at his steps whilst descending. The sixth nerve is more frequently involved in fractures of the base of the skull than any other of the cranial nerves, except the facial and auditory. When torn, convergent strabismus is set up. The **fifth** nerve is but rarely torn or lacerated in head injuries. Either the sensory or the motor root may be torn, or both may suffer. When the sensory root is torn, there is anæsthesia of the whole of the side of the face, with the exception of the skin over the parotid gland. As a secondary effect, destructive inflammation of the cornea may take place. When the motor root is torn, there is impaired movement of the lower jaw, from paralysis of the masticatory muscles. The **seventh** and **eighth** are the most frequently injured of any of the cranial nerves, in fractures of the middle fossa of the base of the skull. When this occurs there is facial paralysis or deafness, or both. Injury to the **remaining four** cranial nerves, as a rule, only takes place in such cases of injury to the head as prove rapidly fatal. Some cases have been recorded where, after a severe injury to the head, the patient has suffered from palpitation, a sense of suffocation, and constant vomiting, which has been attributed to injury to the pneumogastric nerve. The spinal accessory appears to be more commonly injured than the other three. If completely torn across, it leads to paralysis of the sterno-mastoid and trapezius, but it is more frequently irritated at its exit from the skull, by a fracture involving the jugular foramen; under these circumstances it causes spasm in these two muscles, which simulates tetanus.

DISEASES OF THE HEAD

Very few of the surgical diseases of the head require more than a brief mention in this place, as they are common to other parts, and have been, or will be, described elsewhere. Thus in connection with the scalp we may have **erysipelas,** which often occurs from septic wounds, and only differs from erysipelas elsewhere (see page 152) in the fact that, owing to the density of the scalp, the pain is generally more severe than in other situations.

Diffuse cellulitis is another condition which, as we have seen, sometimes follows scalp wounds, which open up the sub-aponeurotic tissue (see page 581).

Abscesses of the scalp are very common, and may be situated in (1) the dense subcutaneous tissue, when they generally arise from eczema or impetigo, or are associated with the presence of pediculi; in (2) the sub-aponeurotic tissue, when they arise from penetrating wounds; or (3) beneath the pericranium, in connection with bone disease.

Tumours of the scalp are common, and may originate in the connective tissue, or in the skin or its appendages.

Tumours arising from the connective tissue are lipomata, angiomata, fibromata, and sarcomata. Of these, the angiomata include nævi and cirsoid aneurisms, already described (page 371). The only tumour of this class which requires special mention is one form of fibroma, which has received the name of *pachydermatocele*, and is the growth described as molluscum fibrosum (page 233) occurring in the scalp. It forms large pendulous masses, most commonly growing from the occipital region, which increase gradually, painlessly, and are more common in the female than the male. The tumour is quite characteristic, and is not likely to be mistaken for anything else. The treatment consists in removal, but the surgeon must be prepared for very considerable hæmorrhage.

Of tumours originating in the epithelial elements of the scalp, the sebaceous cysts are the most common, and are frequently multiple. They have already been described (page 225). Papillomata are not uncommon, occurring in the form of small warty growths, but present no special features. Dermoid cysts occur at the outer angle of the orbit (see fig. 48), but may also be found in other situations, as the anterior fontanelle, at the root of the nose over the nasal eminence, or in the occipital region. Epithelioma is not uncommon in the scalp, arising from an irritated wart, or in connection with a sebaceous cyst. Early and complete removal is the only treatment.

DISEASES OF THE BONES OF THE SKULL

Meningocele, Encephalocele, Hydrencephalocele.—These are names applied to a congenital protrusion of some part of the cranial contents through a hole in the skull, arising from arrest in development of the bones, or non-closure of the sutures. The condition is analogous to spina bifida, as it occurs in the spine. The term *meningocele* is applied to those cases where there is simply a protrusion of the dura mater and arachnoid, and the protrusion consists of a thin-walled cyst containing cerebro-spinal fluid (fig. 228). An *encephalocele* is a protrusion of brain matter which forms a solid but soft swelling. A *hydrencephalocele* is a protrusion of one of the ventricles, and the tumour consists of a central cavity containing fluid, which communicates with the ventricle, inclosed by a thin layer of brain substance, which is the thinned cerebral matter between the ventricle and the surface of the hemisphere. The tumours are generally formed by a protrusion of the anterior horn of the lateral ventricle through an aperture in the skull in the fronto-nasal region (fig. 229). They correspond to the form of spina bifida known by the name of syringo-myelocele.

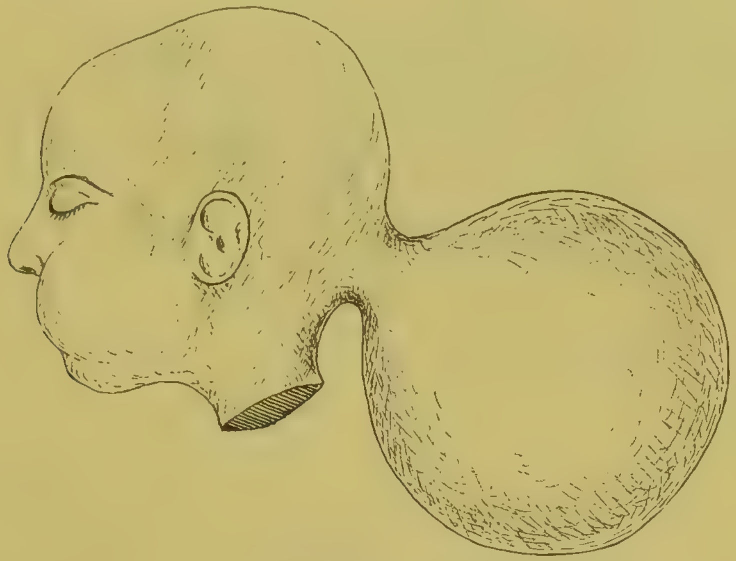

FIG. 228.—Meningocele. (From a cast in the Museum of St. George's Hospital.)

The situation of these protrusions is almost always in the middle line, most commonly in the occipital and the naso-frontal region; but occasionally they protrude at the anterior fontanelle or at the base of the skull, into the mouth or nose. Rare cases are recorded where they have protruded at the external angle of the orbit, or at one of the lateral fontanelles. When they occur in the occipital region, they generally protrude through the expanded portion of the occipital bone, behind the foramen magnum; but in some cases the occipital bone is deficient in the middle line down to the foramen magnum, and even the arches of the first two cervical vertebræ have been found to be deficient, and we have in these cases a transition to spina bifida. The protrusion consists simply of the membranes (meningocele), forming a sac filled with clear fluid, which communicates by a small opening in the bone with the sub-arachnoidean cavity. In some cases the interior of the sac is divided up into numerous loculi by septa (fig. 230).

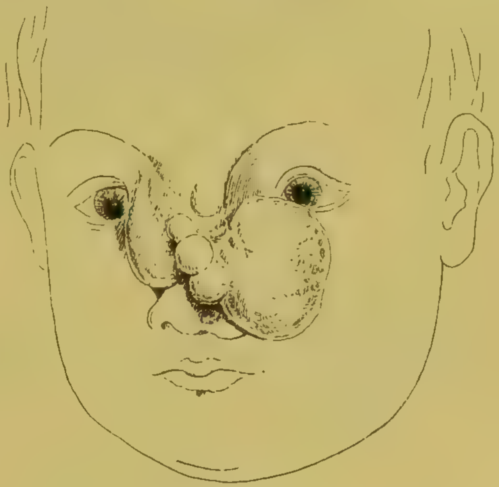

FIG. 229.—An encephalocele in the fronto-nasal region. (From a drawing in the Museum of St. George's Hospital.)

Symptoms.—These protrusions form roundish elastic tumours, which are often pedunculated and are congenital. They are usually covered by normal skin, which is often adherent to the surface of the tumour. A distinct pulsation, synchronous with the action of the heart, can sometimes be felt, more especially in the encephalocele. The tumour becomes harder and tenser on any expiratory effort, as crying or coughing, and can be more or less diminished in size by pressure; the reduction, however, is often accompanied by brain symptoms, such as headache, vomiting, convulsions, and even stupor. In many of these cases the patient dies before reaching adult life, sometimes from giving way of the skin over the swelling and the opening up of the sub-arachnoid or intra-ventricular spaces; or in others from some intercurrent disease. But the malformation is not incompatible with healthy life. It is stated that sometimes in cases of meningocele the cyst may become shut off from the cranial cavity; but there is no actual proof that this really occurs, and at all events such a spontaneous cure is very rare.

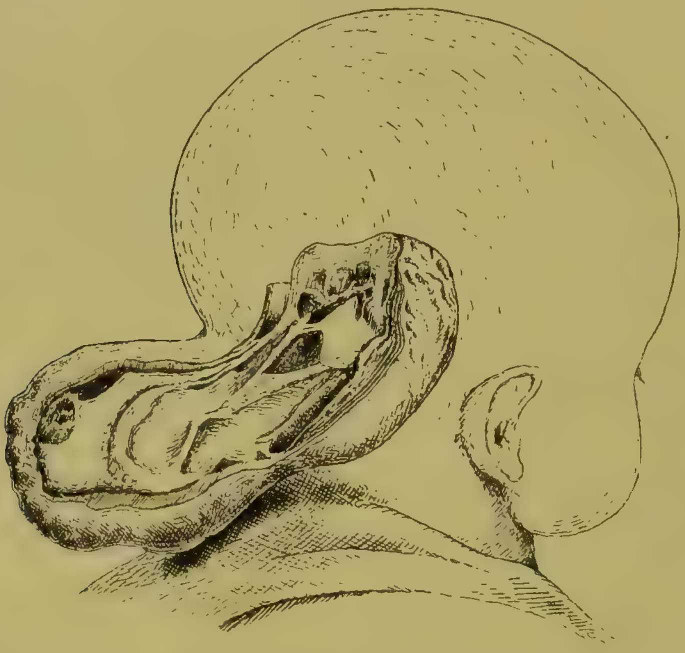

FIG. 230.—Meningocele in occipital region.
(From the Museum of St. George's Hospital.)

The **treatment** in these cases is to simply protect the tumour from injury, and at the same time make slight pressure on it by a carefully moulded shield. No operative interference is as a rule admissible unless the swelling is steadily increasing in size, when an antiseptic puncture, to evacuate the fluid, and subsequent pressure may be employed. In cases of meningocele the injection of Morton's fluid has been tried, but the proceeding is of an exceedingly dangerous nature.

Atrophic changes, such as cranio-tabes, and many **hypertrophic changes,** as those occurring in ostitis deformans, acromegaly, and leontiasis ossea, as well as changes due to rickets and congenital syphilis, may take place in the skull. All these have been described in the foregoing pages.

Of inflammatory affections of the bones of the skull, infective osteomyelitis has already been alluded to as occurring after scalp wounds, exposing and bruising the bone, or after compound fractures (page 582). In addition to this, tertiary syphilitic disease is exceedingly common in the skull; the gummatous deposit taking place either on the surface beneath the pericranium, or in the diploë, and leading to caries and necrosis. Tuberculous disease is also sometimes found in the cranial bones; rarely as a primary affection, more commonly as a secondary result of lupus. It may involve the whole thickness of the bone and cause perforation, or it may destroy only the external table and part of the diploë, and produce a non-perforating ulcer of the bone.

Tumours of the skull.—The most common forms of tumour of the skull are the osteomata and sarcomata; but in addition a few cases of hydatid cysts, probably originating in the diploë, have been recorded. Osteomata have already been described (page 237). The ivory exostosis is the one which is most commonly found in connection with the cranial bones, though cases of spongy exostosis do occur. Sarcomata of the skull may arise either from the pericranium or the diploë, and they may be either primary or secondary growths. When growing from the pericranium they are of the spindle-celled or round-celled variety, and often undergo partial ossification, constituting an ossifying sarcoma (page 244). When growing from the diploë they are usually myeloid. These two conditions can scarcely be distinguished from each other, except at one period of the growth, when 'egg-shaped crackling' may be detected in the myeloid form. They both, as they grow, involve the skin and fungate, and in some instances perforate the bone and implicate the dura mater. When seen early, and especially if the disease is primary, an attempt should be made to remove the growth and the surrounding bone. If the tumour has attained no great size, this can be effected by including the whole in the crown of a large trephine.

Sarcoma of the dura mater (fungus of the dura mater) may occur without apparent cause, or may follow a blow, but most frequently is secondary to sarcoma elsewhere. It springs from the outer layer of the dura mater, absorbs the bone, which becomes thinned and then perforated, and the growth protrudes, implicates the skin and fungates. In the early stage these tumours cause fixed pain in the head and symptoms of cerebral disturbance, such as convulsions, double vision or loss of sight from optic neuritis, and deafness. This is followed by the somewhat sudden appearance of a swelling at the seat of pain. Sometimes the sharp edge of the perforated bone can be felt.

The **treatment** consists in exposing the tumour, enlarging the hole in the bone, and dissecting the tumour off the dura mater. The result is not, however, satisfactory, and if the swelling has attained any size it is perhaps wiser not to attempt operative interference.

DISEASES OF THE BRAIN

In a work on surgery, the only diseases of the brain which it is necessary to allude to are abscess, cerebral tumours, hydrocephalus, and microcephaly, and these only because they may require operative interference.

Abscess of the brain.—We have already seen that abscess of the brain may follow certain injuries of the head (page 603), but a far more common cause of this condition is chronic suppuration in the middle ear, when the abscess may form either in the temporo-sphenoidal lobe or in the cerebellum. In addition to these, syphilitic and tuberculous disease of the bones of the skull may lead to abscess, or pyæmic abscesses may form in the brain.

Abscess of the brain may be acute or chronic. The **acute** form occurs after compound and especially punctured fractures of the skull, and is usually associated with general inflammation of the brain, and cannot be diagnosed as a separate affection. It runs a very acute course, and is accompanied by intense pain in the head, with high fever and probably rigors. Symptoms of compression rapidly supervene, and death.

Chronic abscess of the brain is most frequently caused by suppuration in the middle ear, but may follow scalp wounds from a septic thrombosis spreading inwards (see page 604).

The **symptoms** are often very obscure, and unless there is some cause, such as discharge from the ear, or an injury which may lead us to suspect the formation of matter, the condition is very liable to be overlooked, especially as the temperature in these cases is often subnormal, and rigors are by no means a constant accompaniment of the disease.

Pain in the head—it may be at first general, but after a time becomes localised and fixed—is often the first sign which presents itself. This pain is greatly increased by tapping the skull over its site, and may then sometimes become agonising. Vomiting is almost always present, and may be very persistent. Optic neuritis is a variable sign. In some cases it is to be found in quite the early stage. and is usually more marked on the affected side—it then becomes a valuable sign; but in other cases it does not come on till later, or may not appear at all, so that the absence of optic neuritis must not be looked upon as negativing abscess in the brain. Occasionally epileptic seizures may occur. While these symptoms may be present in most cases, sometimes it happens that they are entirely absent, and the patient becomes comatose and dies without any symptoms, and after death an abscess is found in the brain.

If the difficulties of diagnosis of cerebral abscess are great, the difficulties of localising it are often greater. If it should be situated in the Rolandic area, the position of the abscess can generally be made out by the presence of localised paresis or paralysis of certain groups of muscles. But, as we have seen, these abscesses usually occur in connection with middle ear trouble, and are then situated in the temporo-sphenoidal lobe or the cerebellum. Of the two, abscess in the temporo-sphenoidal lobe is much the more common, and if situated in the anterior part of the lobe might give rise to loss of power in some of the muscles on the opposite side of the body, especially those of the face, and if on the left side to aphasia. On the other hand, if the abscess is in the cerebellum, some amount of want of co-ordination may have been noted in the earlier stage of the disease. The vomiting is also said to be more persistent, and the optic neuritis to develop earlier, where the abscess is in the cerebellum. The matter is not one, however, of vital importance, since, as Mr. Percy Dean has shown, both situations can be explored through the same opening in the skull.

Treatment.—The only treatment in cases of abscess of the brain is to trephine the bone and let out the pus. In those cases where an abscess is supposed to exist in other parts of the brain than in the temporo-sphenoidal lobe or the cerebellum, the skull must be opened over that region where it is thought that the abscess is situated; but when the abscess is due to middle ear disease and is presumably either in the temporo-sphenoidal lobe or the cerebellum, the operation devised by Mr. Dean should be performed.

The skin over the mastoid region having being incised by a horseshoe-shaped incision, and the bone exposed by turning down the flap, the pin of an average-sized trephine is introduced an inch and a quarter behind and a quarter of an inch above the centre of the external auditory meatus, and a crown of bone removed (fig. 231). This will expose a part of the lateral sinus, and the dura mater just above it. By slightly enlarging the opening in an upward direction with gouge forceps, the temporo-sphenoidal lobe can be explored without difficulty. Should no pus be found here, the opening must be enlarged in a similar manner downwards and backwards.

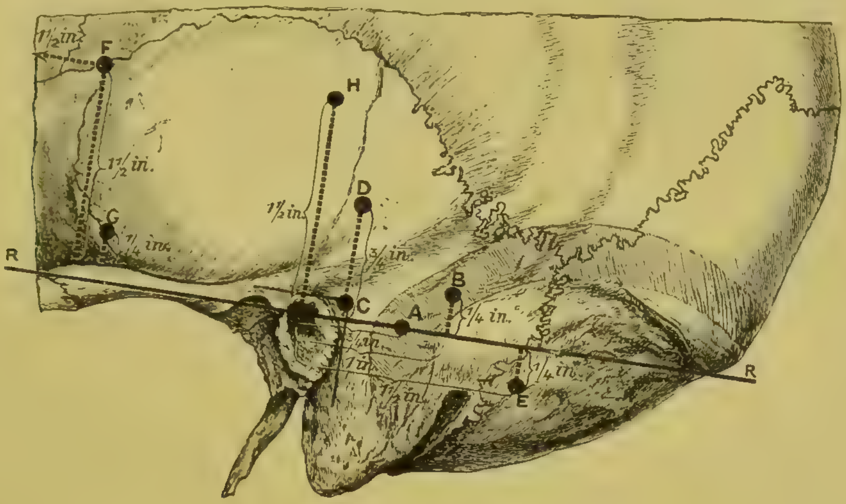

Fig. 231.—Diagram of adult skull, showing the various points for trephining. The horizontal measurements are taken along Reid's base line RR, from the centre of the external auditory meatus; the vertical measurements are taken by drawing lines at right angles to the base line. A, the sigmoid portion of the lateral sinus, a point $\frac{3}{4}$ in. along the base line from the centre of external auditory meatus; B, the transverse part of the sinus, a point 1 in. from external auditory meatus and $\frac{1}{4}$ in. above base line; C, the mastoid antrum, the point of meeting of two lines—one drawn along the upper margin of the meatus parallel with the base line, the other along the posterior margin of the meatus at right angles to the base line; D, for cerebral abscess (temporo-sphenoidal), a line drawn $\frac{3}{4}$ in. upwards through the posterior margin of the meatus at right angles to the base line; E, for cerebellar abscess, $1\frac{1}{2}$ in. behind centre of external auditory meatus and $\frac{1}{4}$ in. below base line; F, for anterior branch of middle meningeal artery, $1\frac{1}{2}$ in. from external angular process of frontal bone, and same distance above upper margin of zygoma; G, for posterior branch of middle meningeal artery, $1\frac{3}{4}$ in. from external angular process of frontal bone and $\frac{1}{4}$ in. above upper margin of zygoma; H, for tapping the lateral ventricle, a point $1\frac{1}{2}$ in. above centre of external auditory meatus. (From Treves's 'System of Surgery.')

This will expose the whole of the lateral sinus and the dura mater below it, and by incising the membrane in this situation the cerebellum can be explored without difficulty. It will be seen also that by the same operation the lateral sinus is exposed freely, and can be examined in cases of lateral sinus thrombosis. When the suspected area of the encephalon is laid bare, an exploring needle should be introduced directly into the brain, and if the presence of pus is ascertained, the opening should be enlarged and the pus evacuated. The cavity may then be gently syringed out, and a drainage tube inserted for a few days.

Cerebral tumours.—The different varieties of tumour found in the brain are: (1) the tuberculous, most common in children, and affecting especially the cerebellum; (2) gummata, almost entirely confined to the adult, and usually attacking the cortex of the brain; (3) glioma, or gliosarcoma, common both in adults and children, and occurring in both the cerebellum and the cortex cerebri; (4) sarcoma, most common in the adult, and usually forming an ill-defined, infiltrating vascular tumour, which is not amenable to removal (fig. 232). (5) Occasionally secondary carcinomatous tumours occur in the brain, and (6) a few cases of hydatid cysts have been recorded. The tuberculous, gummatous, gliomatous tumours and the hydatid cyst are usually well-defined and encapsuled growths, and their removal can be undertaken.

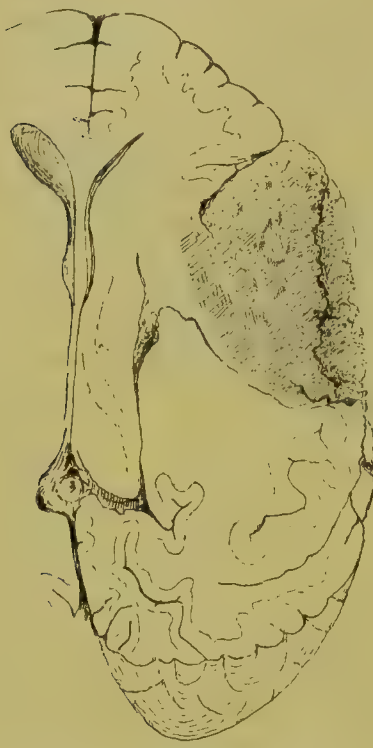
FIG. 232.—Sarcomatous tumour of brain. (From the Museum of St. George's Hospital.)

Symptoms.—The three cardinal symptoms of tumours of the brain are fixed pain in the head, vomiting, and optic neuritis, and these symptoms are progressive in their character and increase in severity. In addition to these, there may be local symptoms when some area of the brain is involved, the functions of which are known; thus there may be paresis or paralysis of certain groups of muscles, or Jacksonian epilepsy, &c. When the tumour is situated in the cerebral cortex, pain of a very severe character is usually induced by pressure applied to the surface of the skull immediately over the tumour. When it is situated in the cerebellum, there is often want of co-ordination of movements. To a certain extent a differential diagnosis must be attempted. If the patient is a child and there are other signs of tuberculous disease, there is a fair inference that the tumour in the brain may be of a tuberculous nature, and these are cases in which operative interference has proved most successful; but, in deciding the question of operation, it must be borne in mind that these tumours may become quiescent and converted into a fibrous mass, though perhaps not before blindness has been produced by atrophy of the optic disc or irretrievable damage done to the brain. If the patient presents the history of syphilis, there is a probability of the disease being a gumma of the brain, and a course of iodide of potassium with or without mercury should be given. Indeed, in most cases of suspected tumour of the brain it is well to subject the patient to a full course of these drugs. The treatment should not, however, be continued too long; probably a couple of months is sufficient time to test whether the drugs are causing any improvement in the symptoms. It must, however, be borne in mind that very often in cases of malignant tumour of the brain the administration of iodide of potassium will produce some apparent improvement at first, from the diminution of congestion which it causes, but this improvement is not lasting. When a suspected tumour of the brain is accompanied by a rapid increase in the symptoms, and fresh portions of brain matter, as indicated by new focal symptoms appearing, become involved one after another, the tumour is probably a diffused one and not amenable to operation. A sudden increase in the signs, followed by stupor and coma, indicates spreading œdema or hæmorrhage in a rapidly growing malignant tumour.

Operation for removal of tumours of the brain.—The exposure of the brain is to be conducted on the plan already laid down (see page 609). When the dura mater is exposed, if there is any increased intracranial tension from the presence of a tumour, it will probably bulge up into the trephine hole; and if the tumour is in the cerebral cortex, the pulsations of the brain may be absent or diminished. Under these circumstances the dura mater must be incised in the manner described above, and the surface of the brain explored; the convolutions may be noted to be flattened or an area of brain matter abnormally hard or soft. If this is not so, a needle should be driven into the brain substance in various directions and any increased resistance to its passage noted. If a tumour is found in or near the cerebral cortex, and if it is circumscribed and encapsuled, it should be enucleated. This is done by isolating it from the surrounding brain substance with Horsley's flexible platinum knife, any bleeding being arrested by sponge pressure or by the application of a fine ligature. After the removal of the tumour, a drain is to be placed in the bottom of the wound, the dura mater sutured, and the external wound closed and dressed. If the tumour cannot be removed, relief to the intra-cranial tension is obtained by the removal of the bone and incision of the dura mater, and probably in most cases of gliomatous and sarcomatous tumour, unless found in quite their early stage, the surgeon will be well advised not to attempt more than this, as the amount of shock attending the removal of a large tumour is very great and the prospects of radical cure very small.

It is now becoming more and more the custom of surgeons to attempt the removal of tumours of the brain, and, indeed, many other cerebral operations, in two stages. The first consists in opening the skull, and the second all subsequent procedures. The latter is not performed until several days after the first. By this means shock is lessened; tumours are oftened partially extruded and their removal rendered easier; and if there is any tension or œdema of the brain, there is an opportunity for it to subside before any interference with the brain substance takes place.

Operation in hydrocephalus.—Cases of chronic hydrocephalus constantly come under the care of the surgeon with a view to relieving the pressure by withdrawing the fluid from the ventricles. This may be done either by aspiration or drainage. Aspiration can only be done in young children before the bones are consolidated, and is usually conjoined with pressure by means of an elastic bandage. It is better to remove the fluid by repeated punctures, than to remove it all at once and run the risk of setting up cerebral symptoms. The operation is most easily performed by puncturing at the outer angle of the anterior fontanelle. The skin, having been rendered aseptic, is incised with a knife to prevent any particles of epithelium being carried into the ventricle on the point of the aspirator. Through this incision the needle is to be introduced, and a moderate quantity of fluid withdrawn very slowly. A piece of gauze soaked in collodion is sufficient to close the wound, and the elastic bandage is then applied. Draining the ventricles was first suggested by Wernicke in 1881, and numerous methods of reaching them have been advocated. It would appear that draining them laterally is more satisfactory than through either the anterior or posterior horns; and the best method is to trephine an inch and a half above the centre of the external auditory meatus (see fig. 231). The trocar is to be introduced directly inwards for a distance of about an inch and a half. In children the measurements must be less, and must vary according to the size of the head. A bundle of horsehairs should be inserted through the cannula and left in as a drain, the wound closed and dressed antiseptically. Neither aspiration nor drainage has been attended with very satisfactory results, though isolated cases have been recorded where it has been followed by recovery; but they are so few that it is very doubtful whether these cases might not have spontaneously recovered even if no operation had been performed.

In cases of hydrocephalus resulting from basic meningitis, attempts have been made to relieve the condition by draining the sub-arachnoid space in the occipital region. The operation is performed by trephining the occipital bone to one side of the crest, below the superior curved line, and incising the dura mater. A probe is then passed inwards towards the falx, and along the falx between it and the cerebellum until the sub-arachnoid space is perforated. This is followed by the sudden escape of cerebro-spinal fluid. A drainage tube is now introduced along the probe. The operation is not devoid of danger, as the medulla oblongata runs a risk of being injured. The results, as far as is known, have been uniformly unfavourable.

Tapping in tuberculous meningitis.—Attempts have been made to cure tuberculous meningitis by relieving intra-cranial pressure, which appears to be the immediate cause of death. This may be done by the operation above described of draining the sub-arachnoid space through the occipital bone. In one case which has been reported, recovery followed the operation. Or the pressure may be relieved by a much simpler method, by puncturing the spinal canal. The child is held in the sitting posture, with the back bowed forwards so as to separate as far as possible the vertebral arches, and the trocar is introduced between the third and fourth lumbar vertebræ, just to one side of the spinous process, until it impinges on the lamina. When this has been done, the point of the instrument is shifted downwards until it is felt to impinge on some soft structure, through which it is driven with a slight inclination to the middle line for about the extent of three-quarters of an inch. On withdrawing the needle, cerebro-spinal fluid will flow from the cannula. In those cases which have come under my own observation, temporary mitigation of the symptoms has certainly frequently been afforded, but in no instance have I seen any permanent benefit.

Microcephaly.—One other condition of the skull requires mention, as it has lately been subjected to surgical interference. This is congenital microcephaly, or diminished size of the cranial cavity, either associated or not with deformity. In those cases where there is no deformity, there has been arrested growth of the brain in early embryonic life, and the skull is small and diminutive, but natural. In the other class of cases, the skull is misshapen and the brain diseased, the disease of the brain giving rise to the alteration in the shape of the skull. The condition is generally associated with idiocy, and with general rigidity of the limbs. An attempt has been made recently to relieve this condition either by linear craniectomy or by removing a portion of the skull on either side. The best mode of proceeding appears to be to divide the skull from the middle line in front to a little distance from the middle line behind on one side, and in ten days or a fortnight to repeat the operation on the other; so that the two incisions meet in front, but behind leave a small portion of bone undivided, which acts as a hinge. A part of the skull cap can then be raised from the brain. The operation is, however, one of very doubtful utility. Temporary improvement as regards the rigidity has been noted in some cases, but no great amount of improvement in the intelligence has been recorded in most of the cases operated upon.

CHAPTER VIII

INJURIES AND DISEASES OF THE FACE

OF THE NOSE

Contusions of the nose are not uncommon, being generally caused by blows with the fist. As there is only a small amount of subcutaneous tissue over the nasal bones, blows in this situation are often accompanied by wounds, and as the parts are freely supplied with blood and the vessels lie close under the skin, the amount of extravasation and swelling is often very considerable, and is attended by great pain.

Wounds of the nose may be inflicted from without or within, through the nostrils. They may vary much in extent : they may simply involve the superficial structures, when the bleeding is generally free, or they may be complicated with fracture of the bones or division of the cartilages.

On account of the great vascularity of the parts, union takes place very readily, and even when portions of the organ have been almost separated they should never be cut away, but should be replaced and adjusted as accurately as possible with horsehair or fine silkworm-gut sutures, having been previously cleansed and rendered as aseptic as may be. In thrust wounds of the nostril there is always a fear that the skull may have been penetrated and the brain injured ; therefore in these cases the patient should be kept at rest and carefully watched for a few days.

Fracture of the nasal bones is always the result of direct violence. The fracture is generally transverse, and is situated most commonly a little above the free lower margin, but may occur at any part of the bone. When it takes place near the root it is frequently complicated with fracture of the cribriform plate of the ethmoid, and may be accompanied by injury to the brain. The broken fragment is generally displaced backwards and to one side, and this gives a flattened and crooked appearance to the nose. Owing, however, to the fact that the injury is produced by direct violence, there is usually very considerable swelling from laceration of the subcutaneous tissues, which may or may not be accompanied by emphysema, and under these circumstances the nature of the injury may be overlooked. This is a matter of great importance, as a broken nose, if not properly treated, leaves a most distressing and unsightly deformity. In many of these cases the fracture is compound, from laceration of the mucous membrane of the nostril, when severe epistaxis may result. The diagnosis can usually be made by grasping the nose and moving it from side to side, when crepitus will be elicited. The septum nasi is sometimes also fractured in cases of injury of the nasal bones, or may occur as an uncomplicated lesion. Occasionally it is bent to one side without being fractured, giving rise to a characteristic deformity.

The **treatment** consists in replacing the depressed fragment as soon as possible. It is generally desirable to administer an anæsthetic in order to do this, as the proceeding always causes great pain, and should be done with care and deliberation. A broad director or elevator is introduced into the nostril, and the bone gently prised back into its normal position. When once replaced, the fragment will often remain in position, and all the treatment that is necessary is to place a piece of strapping across the nose to prevent any displacement. Should there be any tendency to a return of the deformity, the nostril on the affected side should be packed for a few days with gauze, which has been soaked in carbolic oil. This, if properly applied, will effectually prevent any recurrence of the displacement. When the septum is deflected, it can usually be straightened under anæsthesia, but there is a great tendency for it to recur (see page 627).

Foreign bodies in the nostrils.—Children very frequently introduce foreign bodies into the nostrils, where they may cause serious trouble, setting up inflammation and ulceration of the mucous membrane, and sometimes causing disease of the bones. They then give rise to offensive discharge, which may be mistaken for ozæna or tuberculous disease of the bone. It must be borne in mind, however, that the discharge is confined to one side, and when a patient applies with discharge from *one* nostril a foreign body should always be suspected, and a careful examination under anæsthesia made. The foreign body is generally lodged in the inferior meatus, and can usually be detected by a probe, and can be seen if the nostril is dilated with a nasal speculum and illuminated by reflected light. It can be removed with a small scoop or polypus forceps. In removing it the forefinger of the left hand should be introduced into the naso-pharynx in case it should be pushed backwards, when it might find its way into the air-passages.

Rhinoliths are occasionally found. They are formed usually by a deposition of the salts of the nasal discharge around some foreign body introduced from without. They may attain a very considerable size, and give rise to severe neuralgia. They may require to be crushed before they can be removed.

Malformations of the nose are rare and of little surgical interest. The only one to which allusion need be made is occlusion of the nostril. This consists usually in a thin membranous septum which closes the anterior nares, and merely requires an incision for its relief. In other cases the occlusion is much greater, and a considerable depth of tissue has to be cut through. In these cases it is necessary to introduce a piece of hollow tubing—a portion of a gum-elastic catheter for example—and retain it there for some weeks, to prevent adhesions re-forming.

The skin of the nose is subject to many different forms of disease, of which acne rosacea, lipoma nasi, lupus, rodent ulcer, and epithelioma are the most common.

Acne rosacea is the name given to a disease which affects the nose most frequently in women who are the victims of chronic dyspepsia. It commences as an injection of the capillaries of the skin, which become markedly dilated after taking any hot liquid, or sometimes after food, and cause the nose to assume a bright red, greasy and shiny appearance. After a time the sebaceous follicles become involved, and the skin irregularly tuberculated and knobbed. The **treatment** consists in combating the dyspepsia and paying attention to the general health.

Lipoma nasi is a chronic hypertrophy of the sebaceous follicles and surrounding skin and subcutaneous tissues, and not a true fatty growth, as its name would imply. It affects the tip and alæ of the nose, and consists in the formation of a large reddish irregular lobulated mass, which projects from the end of the nose and produces a most unsightly deformity. It is covered with greasy shiny skin, in which are seen a number of pit-like depressions, which are the orifices of the hypertrophied glands. The disease is usually attributed to habitual intemperance, and exposure to cold. The **treatment** consists in shaving away the hypertrophied tissue down to the cartilages of the nose, which must be left uninjured. The rawed surface may then be covered with grafts by Thiersch's method. The results which can be obtained are very satisfactory.

Lupus, rodent ulcer, and **epithelioma** require no special mention, as they present no special features, and they have been already described. They may result in partial or complete destruction of the organ and great deformity.

The nose may require removal in cases of epithelioma, and in these cases, as well as in those where the nose has been destroyed as the result of traumatism or tertiary syphilis, the surgeon may be called upon to exercise his art in attempting to form a new nose. The operations are not as a rule very satisfactory, as the new nose, consisting of only soft structures, is very apt to shrivel up, contract and become quite flat; so that in most cases the patient will be well advised if he trusts to the instrument maker to remedy his deformity by modelling an artificial nose, rather than submit himself to operation. At all events the proceeding should only be undertaken in the healthy and fairly young, and where the cause of the destruction is local and has been entirely removed. The operation is performed by taking flaps from different situations: from the forehead by the Indian operation; from the inside of the arm by the Tagliacotian operation; or from a finger by Bloxam's operation. The student is referred to works on operative surgery for a description of the details of these operations, for which space cannot be found in this work.

DISEASES OF THE NASAL FOSSÆ

An examination of the nasal fossæ can be made by anterior or posterior rhinoscopy.

Anterior rhinoscopy consists in illumination of the front of the nasal cavity through the anterior nares. This may be done by bright daylight or by a strong light thrown in by means of a mirror, or by a small electric lamp fixed to the forehead of the surgeon. The anterior nares are dilated by some form of nasal speculum, of which Cresswell Baber's is probably the best (fig. 233). If the patient's head is thrown back, the whole of the inferior meatus, the inferior turbinated bone, sometimes a part of the middle turbinated bone, and the lower part of the septum can be explored. It is advisable to spray the nostrils with a 5 per cent. solution of cocaine before the examination, not only because it saves the patient pain, but because it produces shrinking of the soft vascular structures which cover the turbinated bones, and thus gives a more extensive view.

Posterior rhinoscopy, or examination of the posterior nares with a mirror, is a difficult proceeding, and in children is generally impossible. A far greater amount of information as to the condition of parts can be obtained by inserting the forefinger into the naso-pharynx than by the momentary glimpses that can be obtained by introducing a small mirror behind the uvula and soft palate. If an attempt is made to get a view of the parts by posterior rhinoscopy, the throat should be well cocainised, and the patient placed in a chair in front of the surgeon. A strong light is then thrown into the back of the throat by a reflecting mirror; the soft palate is drawn downwards and forwards by a small hook-shaped spatula, and the rhinoscopic mirror inserted into the naso-pharynx, care being taken not to touch the posterior wall of the pharynx. By this means, in a tractable patient, the posterior nares, with the posterior extremities of the middle and inferior turbinated bones and the inferior meatus, the vault of the pharynx, and the orifices of the Eustachian tubes can be seen.

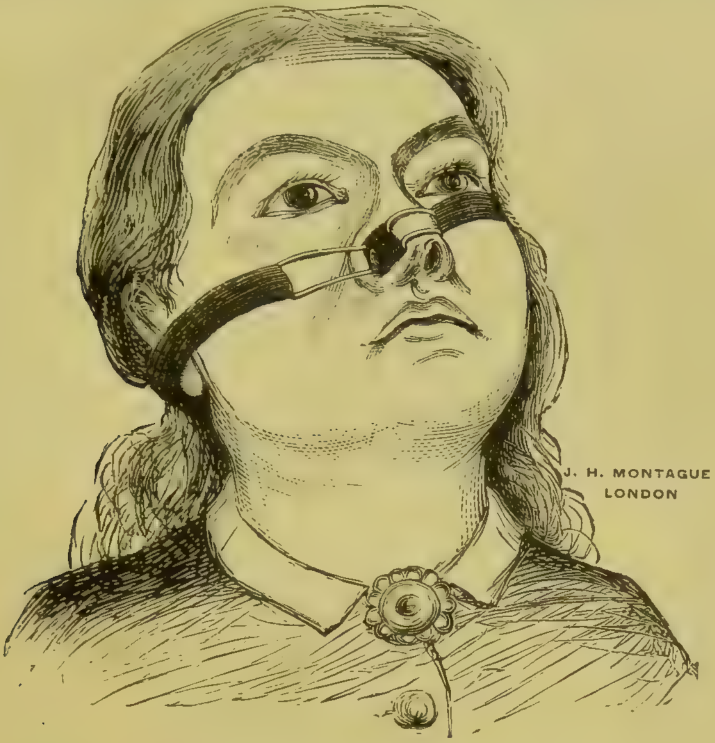

FIG. 233.—Cresswell Baber's self-retaining nasal speculum.

Epistaxis, or bleeding from the nose, is a very common condition, and may arise from a variety of causes. It occurs in consequence of injuries, as in fracture of the anterior fossa of the base of the skull, and of the nasal bones; from the presence of foreign bodies, from slight erosions or ulcerations, generally on the septum; or from rupture of a small vessel, especially if varicose, during violent blowing of the nose or sneezing. It may also arise from new growths in, or in the neighbourhood of, the nasal fossa; these are principally nævoid growths, sarcomatous or epitheliomatous tumours. But, in addition to these causes, epistaxis may occur spontaneously, both in youth and old age. In children, and up to the age of puberty, slight bleeding from the nose very frequently takes place, usually from some congestion of the mucous membrane and local disturbance in the circulation of the part. It is a matter of no consequence, and will almost always stop in a little time, unless the child is the subject of hæmophilia. In young women, epistaxis is sometimes vicarious when the catamenia are suppressed; but this is far from being a common condition. In advanced life, epistaxis is of more serious import, and may occur in the plethoric, when it is often indicative of cerebral congestion; or it may occur in the cachectic or anæmic, or in those suffering from Bright's disease, pernicious anæmia, leucocythemia, &c. It also occurs in patients suffering from purpura and scurvy. In these cases it may prove fatal from repeated recurrences.

Treatment.—The treatment of epistaxis must depend upon the cause. In the epistaxis of children the bleeding may generally be arrested by placing the child in the recumbent position and raising the arms above the head; the usual position of bending the head over a basin has a tendency to increase the hæmorrhage. At the same time the nostrils may be pinched between the finger and thumb until clotting of the blood in the vessels has taken place. A recurrence must be prevented by regulating the diet, enjoining more exercise, and administering purges. In hæmorrhage from the nose in full-blooded, plethoric individuals the bleeding should not be too suddenly checked, as it may be the means of averting graver mischief by relieving the cerebral congestion. But in people advanced in life and who are anæmic, or in those suffering from scurvy or purpura, active measures must be taken to arrest the hæmorrhage, which may otherwise prove serious. This may usually be effected by freely washing out the nares with ice-cold water by means of the nasal douche, and by the administration internally of gallic or tannic acid or liquid extract of ergot. The nasal douche consists of an india-rubber tube, one end of which is placed in a receptacle raised above the patient's head, and the other has a nozzle attached to it which is inserted into one nostril so as to completely fill it (fig. 234). The patient sits with his mouth open, breathing through it, and abstains from making any movement of deglutition. The receptacle being filled with ice-cold water, or with some astringent solution, a constant stream of fluid will pass from the one nostril through the naso-pharynx into the other, and flow out of the anterior nares without entering the mouth.

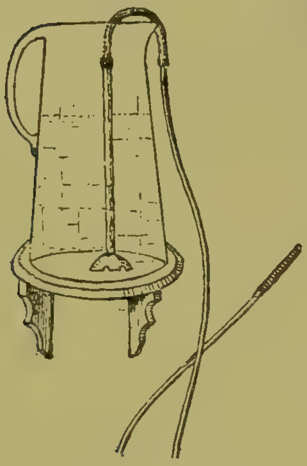

FIG. 234.—Nasal douche.

Should this plan of treatment fail, the nostril may be plugged with an india-rubber tampon, consisting of a thin india-rubber bag, which is pushed up into the nostril by means of a probe or director in a collapsed state and then blown up, and the air retained in the bag by means of a stopcock attached to it. One or other of these methods will usually succeed in arresting the hæmorrhage, and it is rarely necessary nowadays to plug the posterior nares. This operation is one not devoid of danger, especially in old people, and should never be resorted to unless absolutely necessary. It is best effected by means of Bellocq's sound (fig. 235), or, if this is not available, a soft Jacques catheter may be used. The sound or catheter is introduced along the floor of the nostril until the end appears in the pharynx. If the sound is used, by pressure on the knob, the stilet is made to protrude, and curves forwards into the mouth; if the catheter is used, the end can be seized with a pair of dressing forceps and drawn into the mouth. To the end of the stilet a string is attached, and the instrument withdrawn. In this way a piece of string is made to pass round the soft palate, one end hanging out of the nostril, the other out of the mouth. To the middle of the piece of string which projects from the lips a piece of sponge or lint, the size of the terminal phalanx of the patient's thumb, is fastened, and is drawn up into the posterior nares by pulling at the end of the string which hangs out of the nostril. There is no difficulty in getting the plug around the posterior nares, if the attempt is made in the following way. The plug is pushed to the back of the mouth with the forefinger, and the patient is then told to swallow; at the moment the act of deglutition takes place, the string is pulled and the plug is at once drawn up into position. When the bleeding has ceased, the plug can be withdrawn by pulling at the string hanging from the mouth.

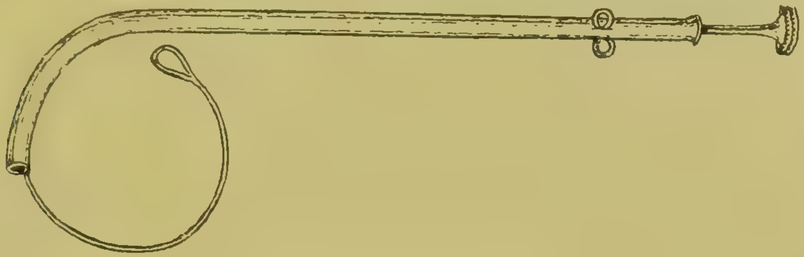

FIG. 235.—Bellocq's sound.

Deviation of the septum may be the result of injury (see page 622), or may be the result of a congenital malformation. It is usually a matter of minor importance, but in some cases the deviation is so great that the septum touches the outer wall of the nares and obstructs the passage of air, causing great discomfort to the patient. Under these circumstances it is necessary to take measures to remedy the deformity. This can generally be done by introducing a pair of flat-bladed forceps into the nostrils and bending the septum straight. This very often only succeeds for a time, and the deviation recurs. If it does, a square flap of the mucous membrane may be dissected up from the surface of the septum on that side to which it is deflected, and a portion of the septal cartilage cut away, care being taken not to remove too much, for fear of sinking in of the nose; the flap is then replaced, and secured with a stitch or two of horsehair.

Hypertrophy of the mucous membrane; chronic rhinitis.—This disease, which is of very frequent occurrence, is credited with giving rise to many reflex phenomena, such as attacks of sneezing, tinnitus aurium, cough, vertigo, and even epilepsy, and is always a source of great discomfort to the patient. It consists in an hypertrophy of all the structures entering into the formation of the mucous membrane, with myxomatous changes; the disease especially affects the anterior extremity of the inferior turbinated bone, where it produces a distinct enlargement, which may be mistaken for a polypus.

It is usually believed to be due to repeated attacks of irritation from cold, the inhalation of dust, irritating vapours, or tobacco smoke, and occurs in those individuals where the nasal passages are narrow. It produces a sensation of obstruction and profuse mucous secretion. Patients complain of having a perpetual cold in the head; they breathe through the mouth and snore when asleep. Upon examination by anterior rhinoscopy the nostril will appear to be more or less blocked with a mass of gelatinous, greyish material, which may be mistaken for a polypus, but it is sessile and the probe cannot be made to encircle it, as it can a polypus.

Treatment.—The treatment of this condition consists in attention to the general health, residence in a dry climate, and the washing out of the nasal cavity three or four times a day with a lotion containing biborate of soda, bicarbonate of soda, and chlorate of potass. The washing out is best done by means of a ball syringe with an india-rubber nozzle, which completely fills the nostril. Should this not succeed, linear scarification with the galvano-cautery under cocaine will almost always effect a cure. It should be mentioned that the application of cocaine causes shrinking of the growth and relief for a time, but it is not permanent.

Ozæna.—By the term *ozæna* we mean a peculiar fœtid discharge from the nostril. Formerly the term was applied to any foul discharge such as may occur in syphilitic or tuberculous disease of the nose, but the word is now given to a definite form of disease which is the result of definite changes in the mucous membrane ; while the terms *syphilitic* and *tuberculous* ozæna may be used for those cases where the offensive discharge is the result of changes induced by these constitutional diseases. The changes in the mucous membrane which cause true ozæna are of an atrophic character. There is an increase in the fibrous element of the mucous membrane, which encroaches on and obliterates the blood-vessels ; and from malnutrition the gland tissue and epithelium undergo fatty degeneration. In consequence of this there is a diminution of the secretion, and what there is dries and forms crusts on the surface and undergoes decomposition. A particular organism, the *bacillus fœtidus ozænæ*, has been constantly found to be present, but it has not yet been proved that this is the originator of the malady. The cause of the disease is unknown ; it usually occurs in young and delicate children, especially among the poor, and has been attributed to injury, to tuberculous disease, inherited syphilis, and is said by some to follow the exanthematous fevers, but nothing is known with certainty as to its etiology. One characteristic which has been noticed is that it almost always occurs in individuals with wide nostrils and flattened noses.

The offensive odour, which has been likened to the smell of bugs, is generally the first thing which attracts attention. Upon examination of the nares it will be found that the mucous membrane is covered with greenish adherent crusts. If these are separated, the surface beneath will be seen to be dry and pale, and to have entirely lost its vascular velvety appearance. There is usually little bleeding on removal of the crusts. The sense of smell is very often partially or completely lost, but in some instances the patient may be conscious of the disgusting odour.

Treatment.—The treatment of ozæna consists mainly in getting rid of the putrefying secretion and keeping the nasal cavities clean. This will do much to ameliorate the condition and render the patient inoffensive to those around, but it is doubtful whether, when the disease is thoroughly established and the mucous membrane has undergone the atrophic changes mentioned above, a complete cure can ever be obtained. The plan of treatment consists in well irrigating the nares, night and morning, with warm water, or water to which a little salt has been added, in order to render it less irritating. This is best done by means of the syphon douche described above (page 626), care being taken not to raise the receptacle to too great a height, otherwise the fluid may be forced up the Eustachian tubes. By this means the stinking crusts will be loosened and washed away. When the cavities are cleared some antiseptic remedy should be applied to the exposed surfaces. The best mode of applying this is to impregnate some cotton-wool tampons with the antiseptic in the form of an ointment, and introduce these lightly into the nostril. The antiseptic which has answered best in my hands is iodoform, the disagreeable odour of which may be disguised by a little oil of bitter almonds (iodoform, ʒj ; ol. amygd. amar. ♏v ; lanolin and vaseline, āā ℥ss). At the same time the general health must be attended to. This plan of treatment will usually materially relieve the patient and enable him to live in comfort ; but he should be told that it will probably be necessary for him to continue the douche at least once a day for many years, though he may be consoled by being informed that the malady lessens with advancing years.

Syphilitic ozæna.—Gummata in syphilitic cases are apt to form under the periosteum of the nasal fossæ. These soften and break down and form ulcers, often associated with necrosis, which gives rise to an exceedingly fœtid discharge of a yellowish colour. The disease can be distinguished from true ozæna by the profuse discharge, by the presence of other syphilitic lesions, and by the detection of exposed bone upon examination. The **treatment** must consist in the appropriate constitutional remedies for syphilis—iodide of potassium or mercury—and in the constant irrigation of the nares by means of the syphon douche with some antiseptic solution, of which perhaps potassium permanganate is the best. The douching will generally loosen and bring away the necrosed bone in the form of black, crumbling, offensive pieces. If not, they must be removed with forceps as they become loosened.

Tuberculous ozæna.—Tuberculous children are subject to an offensive discharge from the nostril, which arises from a tuberculous ulceration of the mucous membrane of the nares. This is accompanied by purulent discharge, and, like the syphilitic form, may be associated with disease of the bones, which may lead to flattening of the nose and great deformity. Upon examination of the anterior nares the mucous membrane is found to be much thickened and often deeply ulcerated ; the ulcers being frequently covered by black adherent crusts. The **treatment** is the same as in the syphilitic form of the disease as regards the local measures, namely, by persevering use of the douche ; whilst internally cod-liver oil and iodide of iron should be administered, with strict attention to dietetic and hygienic measures.

Ethmoiditis.—The upper part of the nasal fossæ is occasionally the seat of a septic inflammation, which appears generally to be due to septic infection from without, and usually begins in the middle turbinated bone, and from this may spread to the other parts of the ethmoid and to the various sinuses connected with the upper part of the nasal fossa, and in some instances through the cribriform plate to the membranes and substance of the brain. The disease begins as an infiltration of the submucous tissue, which rapidly runs on to suppuration, and spreads to the periosteum covering the bones, which become necrosed. When the sinuses are implicated they are filled with pus. In some cases the cavernous sinus is thrombosed, and a general condition of pyæmia set up. The disease is characterised by severe, deep-seated pain about the bridge of the nose and back of the orbit, with redness, swelling, and discharge of pus from the nose, which is usually not offensive. Upon examination of the interior of the nostril, the upper part is found to be blocked with a mass of granulation tissue, and a probe passed into this mass can usually be felt to reach exposed bone. There is often high fever, rigors, and delirium. The

treatment consists in maintaining cleanliness as far as possible, and draining. The granulation tissue should be scraped away with a small curved curette, and all carious bone removed. The ethmoidal cells should be opened up with all gentleness and care, and the parts thoroughly syringed out with antiseptic fluids and drained. If the frontal sinuses are involved, which will be indicated by severe frontal headache and swelling over the forehead and inner part of the orbit, they must be opened by an incision over them, and the bone perforated with a gouge or trephine. The lining membrane of the sinus should be scraped away and the passage into the nose dilated, so as to allow of drainage through this cavity. The wound on the forehead is then to be sutured, the drainage tube being left in situ for some days.

The **frontal sinuses** are sometimes the site of inflammation from other causes, besides that enumerated above, and *sinusitis*, as it is termed, is believed by some to be a not unfrequent sequel of influenza. If under these circumstances the infundibulum becomes blocked, the sinuses become distended with mucus, and perhaps subsequently with pus. This causes a slowly growing swelling, accompanied by much pain, at the root of the nose, which when suppuration occurs becomes red, and the pain of a throbbing character. The characteristic seat of the pain is at the upper and inner wall of the orbit, and pressure in this situation causes greatly increased pain. The dangers of this affection are that the mischief has a tendency to extend through the inner wall of the sinus and set up cerebral mischief; or to extend to the cavernous or other venous sinuses, producing thrombosis. The treatment consists in laying the cavity open and draining it. This is done by an incision slightly above the supra-orbital arch carried down to the bone, which is then trephined or opened with a gouge. The contents are evacuated, and the infundibulum dilated, so as to allow of free drainage. The wound in some cases heals up, but not unfrequently a fistulous opening is left. Hebinger and Fehleisen therefore recommend the removal of the whole of the anterior wall, and under these circumstances the infundibulum is not reopened for fear of infection from the nose, but the cavity is stuffed and allowed to granulate up from the bottom.

Polypus of the nose.—Two forms of nasal polypus have to be described: the simple nasal polypus, mucous and gelatinous in character, and the naso-pharyngeal polypus, fibrous or fibro-sarcomatous in nature. To these is sometimes added a third—the malignant polyp; this form of disease, however, usually springs from the superior maxillary bone, and will be described with affections of that part.

The **simple nasal polypus** (*mucous* or *gelatinous polyp*) is a soft, moist, gelatinous tumour, which usually springs from the outer wall of the nasal fossa, more especially from the middle turbinated bone or its immediate neighbourhood, though cases have been recorded where it has been found springing from the roof and even the septum, and from the sinuses communicating with the nasal fossæ. These tumours vary much in size, and are always multiple. What usually happens is that one polyp attains a large size, and a number of smaller ones grow from the mucous membrane around. They are generally pedunculated, the pedicle in some instances being thin and attenuated, at others broad and giving origin to a lobulated mass (fig. 236). On microscopic examination the growth is found to consist of extremely delicate fibres of connective tissue, forming a network in which is contained a large amount of mucous fluid. Embedded in this are stellate cells the processes of which are continuous with the fibres, and resemble those of myxomatous tissue. The growth is therefore very commonly regarded as myxomatous in nature, but by some is believed to be inflammatory in origin, and to consist of loose connective tissue infiltrated with mucin. Superficially the growth is covered by columnar ciliated epithelium, except when it protrudes from the nostril, when the protruded part, which becomes firmer and harder than the rest of the growth, is covered by squamous epithelium. The causes of the condition are obscure. It is usually attributed to prolonged catarrh, from the irritation of a dust-laden atmosphere, or constant exposure to damp and cold.

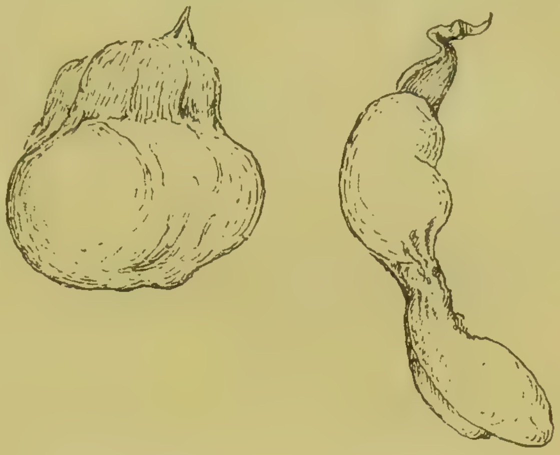
FIG. 236.—Simple or gelatinous nasal polypus. (From the Museum of St. George's Hospital.)

Symptoms.—The symptoms are those which are due to nasal obstruction. The patient is unable to breathe through the affected nostril, and if both nostrils are involved, breathes through the mouth and snores at night. This is usually accompanied by a constant mucous discharge from the nose, which is sometimes blood-stained. These symptoms are always worse in damp weather. The speech is generally affected, being thick and nasal, and in bad cases the nostrils are mechanically expanded. By means of the nasal speculum the growth can generally be seen, especially if the patient is instructed to blow down forcibly ; and a probe introduced by the side of the growth can be made to travel completely round it and thus serves to distinguish it from thickening of the mucous membrane, with which it is liable to be mistaken. Sometimes when the growth originates from the posterior part of the turbinated bone, it projects backwards, and is then likely to be overlooked unless the pharynx is explored with the finger or by rhinoscopy. The slow growth and consistence are sufficient to distinguish these tumours from malignant polypi.

Treatment.—The treatment of nasal polypi consists in their removal, and this may be done either by means of a snare or with forceps. The latter plan is often spoken of as being barbarous and unsurgical, and it is the fashion nowadays to condemn it and to advocate the use of the snare. But in spite of its being somewhat rough surgery, it possesses this great advantage, that if properly conducted, the cure may be effected in the course of a couple of minutes ; whereas in the treatment by the snare 'many sittings are usually required, and the case must be kept under observation for some months.' Another objection that has been raised to the treatment by avulsion is that it is extremely painful, and no doubt this is so, unless an anæsthetic is given ; but there is no reason why an anæsthetic should not be given in these cases. The operation is performed as follows : the patient is laid on a table, and chloroform or ether given until he is thoroughly anæsthetised. The head is then brought to the edge of the table and the face turned over it, so that the nostrils are dependent ; the surgeon, kneeling before the patient, passes a pair of polypus forceps open into the nostril, with one blade on either side of the growth, until he reaches the bone from which the growth springs, and seizing it in the forceps breaks it off. This will bring away the turbinated bone, with one or more large polypi attached to it, and in addition a whole crop of small polypi, which could not be removed without taking away the mucous membrane from which they grow. The forceps used should be long, with deeply serrated but delicate blades, which are fenestrated. It will be found that, though the bleeding is generally free for a minute or two, if the patient's head is placed in the position indicated no blood will run down the throat. To remove nasal polypi with a snare, a good light is required; a speculum is inserted and the wire loop passed round the growth, so as to encircle the base. The polypus may then be removed by the galvano-cautery, or by gradually tightening the wire and cutting it off.

Naso-pharyngeal polypi are outgrowths from the thick muco-periosteum which covers the base of the skull, and forms the roof of the pharynx; they are fibromatous at first, but in many cases tend to become sarcomatous as they grow. They are in the early stage firm, fleshy, pedunculated tumours (fig. 237), which as they increase extend into the nasal cavities, displacing the bones. and into the pharynx at the same time. This continued growth causes various symptoms from pressure, as deafness, epiphora, &c., and they may force their way into the orbits or any of the other surrounding cavities, or may even absorb the base of the skull and cause pressure on the brain.

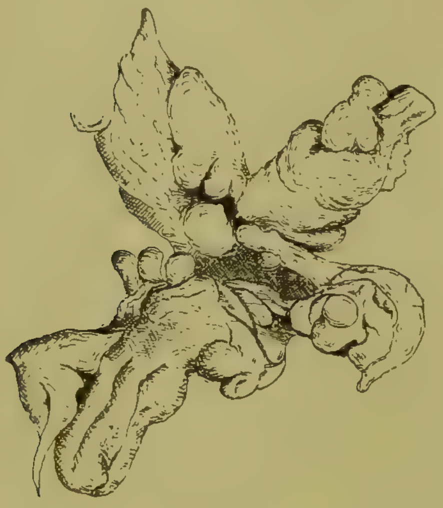

FIG. 237.—Naso-pharyngeal polypus which grew from the under surface of the body of the sphenoid bone, between the two pterygoid processes. Removed by operation. (From the Museum of St. George's Hospital.)

The **symptoms** they produce are those of nasal obstruction, usually accompanied by severe epistaxis, and I have known this bleeding to go on, from the cause of it having been overlooked, until fatal consequences were threatened. In every case of severe epistaxis accompanied by signs of nasal obstruction a careful examination of the naso-pharynx should be made, as when the growths are small and polypoid their removal can be easily undertaken, and is not, as a rule, attended by serious hæmorrhage; while after they have attained a large size and projected forwards among the cavities of the face their removal constitutes a formidable operation.

Treatment.—When the tumour is small it is perfectly easy to twist it off from the mouth with a pair of suitably curved forceps, or to divide the pedicle by a galvano-écraseur introduced through the anterior nares. In cases, however, where the growth has attained considerable dimensions, a way must be made by surgical operation through the tissues of the face to reach the base of the tumour; and many different plans have been devised to attain this end, either from below through the hard and soft palate, from above through the nose, or from the front through the upper jaw. Of these the best method and the one which is usually adopted, as giving the freest access to the tumour, is by the resection of a whole or a part of the superior maxillary bone.

Adenoids of the naso-pharynx.—This disease is of very common occurrence, especially in tuberculous children, and is often associated with enlargement of the tonsils. The mucous membrane of the upper part of the pharynx is rich in lymphoid tissue, either collected into a special mass, the pharyngeal tonsil, or diffused over the whole of the mucous surface ; and the disease under consideration consists in an hypertrophy of this tissue, caused by exposure to damp, unhealthy hygienic surroundings, or any condition which tends to cause a chronically inflamed state of the throat. The adenoids form masses of soft vegetations, growing principally from the roof and posterior wall of the pharynx. They are sometimes pedunculated, but for the most part form broad sessile spongy masses, which may completely block the posterior nares.

Symptoms.—The symptoms are for the most part due to the obstruction to nasal respiration which they produce. The mouth is half open, so as to allow the child to breathe through it, and the lips are dry and cracked ; the teeth are often carious from exposure to air in mouth breathing. The nostrils are drawn in and pinched. This gives to the child a very characteristic appearance, so that the existence of adenoids may be diagnosed by the vacuous, semi-idiotic expression produced. In addition to this the child is reported to snore at night, and sometimes to wake up with sudden attacks of choking and 'night terror.' In many cases deafness is a complication of this disease, from an extension of the chronic inflammation to the mucous lining of the Eustachian tubes, and this condition may extend to the tympanum, and perforative otorrhœa result. Upon examination of the mouth the soft palate may be found to be depressed, and occasionally portions of the growth may be seen projecting behind it, or lumps of stringy mucus may be seen clinging to the back of the pharynx. On introducing the index finger behind the palate, the soft growths can be readily felt, and usually slight bleeding is produced by the examination, so that the finger is tinged with blood when withdrawn. It is seldom possible to obtain a view of the growths in children by posterior rhinoscopy. In neglected cases of long standing, considerable deformity of the chest wall may result from the defective power of inspiration.

Treatment.—The only treatment for this condition is removal of the growths. And if the disease is sufficient to produce impediment to nasal respiration, the operation should at once be recommended. It is true that the growths have a tendency to disappear when adult age is reached ; but then the mischief is done, the development of the child has been interfered with, possibly permanent deafness may have been induced, and the chest may have become deformed. The results of the operation are most satisfactory, and if the growths are entirely removed there does not seem to be much liability to recurrence, though, if any portions are left behind, a recurrence is far from uncommon.

The operation may be performed as follows. Chloroform should be administered, and if the tonsils are also enlarged they should first be removed. The child is then placed on its back on a table, so that its head hangs over the end. The mouth is held open with a Mason's gag, and the tongue drawn out of the mouth with a pair of tongue forceps.

Several different instruments are used for removing the adenoids, of which the principal are Gottstein's ring knife, Löwenberg's forceps, and the artificial nail. Each surgeon will probably use the instrument with which he is most familiar, but in my hands the ring knife has proved the most efficient. This knife is rapidly introduced through the mouth behind the palate, and is pressed firmly against the posterior wall of the pharynx and drawn downwards three or four times, so as to scrape the posterior wall. The finger is then introduced, and the remainder of the growth scraped away with the finger nail, special attention being paid to the orifices of the Eustachian tubes and to the posterior nares.

The bleeding is often very profuse, and as soon as the operation is completed the child should be turned over into the prone position, so as to allow the blood to run out of the mouth. The bleeding usually quickly ceases; if not, the pressure of a sponge introduced behind the soft palate will arrest it. The after treatment consists in syringing out the nose and mouth with a weak antiseptic solution, and keeping the child in the house for two or three days.

Injuries and diseases of the cheeks and lips.—Wounds about the cheeks and lips are of common occurrence, but on account of their free vascular supply they unite readily. They present no features of any peculiarity, and the only point which requires especial mention is the treatment. This should be conducted with the greatest care, and the edges of the wounds brought accurately into apposition, so as to prevent scarring as far as possible. After having been thoroughly cleaned and all foreign bodies removed, they should be carefully adjusted and united, if superficial, with horsehair sutures, or, if deeper and involving the whole thickness of the lip or cheek, with fine silver wire. Even if the edges of the wound are considerably contused and lacerated they should be united, for although the edges may slough, the deformity will be less than if the margins of the wound had not been brought together. After the wound has been closed it should be covered with one or two layers of gauze, over which collodion is painted, and the whole covered with a layer of dry wool. It must be borne in mind that the sutures themselves cause marks if left in too long. They should therefore always be removed within forty-eight hours of their insertion.

Salivary fistula.—It occasionally happens that in wounds of the cheek Stenson's duct is laid open or divided across; in consequence of this the saliva escapes from the opening in the duct and prevents the external wound closing. In this way a salivary fistula may be formed. This condition may also arise from the formation of an abscess in connection with the duct, generally caused by an impacted salivary calculus. A salivary fistula, when formed, causes great annoyance and discomfort; as soon as the patient begins to eat, the saliva commences to flow down the cheek, the skin around becomes excoriated, and the orifice of the sinus is usually surrounded by a few small granulations.

Treatment.—The cure of this condition is often very difficult. If recent, the opening can sometimes be closed by one or two applications of the Paquelin or electric cautery; but when this fails, the treatment must vary according to whether the distal end of the duct can be found or not. If it can, a very flexible probe or a gum-elastic catheter of the smallest size is to be introduced through the orifice of the duct in the mouth, which is to be found opposite the second upper molar tooth, and carried along the duct until it emerges at the fistulous opening on the cheek. The opening of the proximal end of the duct is now to be sought for, and can be found by noting the exact spot where the saliva flows from. When found, the end of the probe which has emerged at the fistulous opening is to be bent down and inserted into the orifice, and pushed some little distance up the proximal part of the duct. The probe is now to be withdrawn from the mouth until it lies evenly in the duct, across the wound;

the end is then bent up round the angle of the mouth on to the cheek, and fixed there with strapping. The saliva being thus guided into the mouth by the probe, will not flow out through the fistula, and this will in many cases heal. When it does not, or when the opening of the duct into the mouth cannot be found, the disease must be treated by making a new passage for the saliva from the gland into the mouth. A straight needle armed with a stout piece of silver wire is passed from the bottom of the fistula through the cheek into the mouth, with an inclination backwards. The needle is withdrawn from the mouth and unthreaded. It is then threaded on to the other end of the wire which projects from the cheek, and the needle is again introduced through the fistula, but with an inclination forwards, into the mouth, so that a loop of wire now presents externally and the two free ends in the mouth, at a distance of about half an inch from each other (fig. 238). The two ends are to be twisted tightly, so as to strangle the intervening tissue, and the loop of wire allowed to ulcerate its way into the mouth. When it comes away a triangular gap, with its apex at the opening in the duct, will be found, through which the saliva will easily find its way into the mouth. If the edges of the external fistulous opening are now cauterised, it will probably heal.

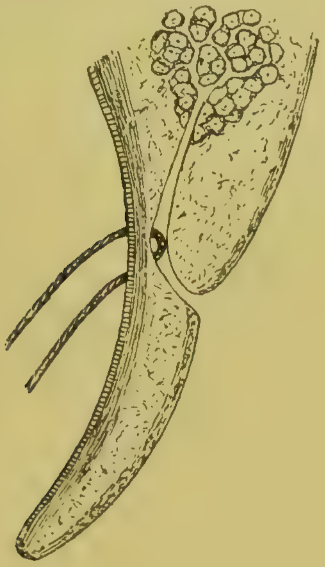

FIG. 238.
Treatment of salivary fistula.

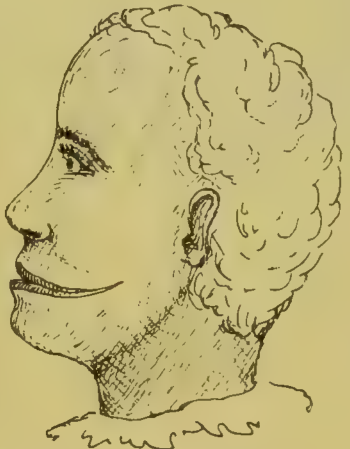

FIG. 239.—Macrostoma.

Malformation of the lips.—The various malformations of the lips are due to defective blending together of the five processes around the primary mouth orifice, which by their development form the face. The most common of these is hare-lip, which in its usual form is due to a want of complete union between the fronto-nasal and the maxillary processes; but in addition to this there are some rarer malformations, which it will be convenient to allude to first.

Macrostoma arises from a want of fusion between the maxillary and mandibular processes, and results in the formation of a fissure, which may be unilateral or bilateral, extending from the angle of the mouth into the cheek (fig. 239). It may vary much in extent, from a slight gap at the angle of the mouth to a cleft which may extend as far as the last molar tooth or even farther. It produces a most unsightly deformity, more marked when the facial muscles are put into action. The nutrition of the child is interfered with, it cannot suck, and food put into its mouth runs out again. It must be fed with a teaspoon introduced well into the back of the mouth. If the child can be fed in this way, it is wiser to defer any surgical proceeding until the infant is better able to withstand the shock of the operation and the loss of blood. The cure consists in paring the edges of the cleft and uniting them accurately with sutures; it is advisable to use one or two silver sutures as mainstays, and then accurately adjust the cutaneous and mucous surfaces with horsehair sutures.

Microstoma is the converse of macrostoma, and arises from too great a fusion of the maxillary and mandibular processes. In these cases the orifice in the mouth is contracted, sometimes to such an extent as barely to admit a probe. It is said that in some cases complete closure has been met with. The **treatment** consists in enlarging the opening on either side in the natural direction of the mouth, and then suturing the cutaneous and mucous surfaces together.

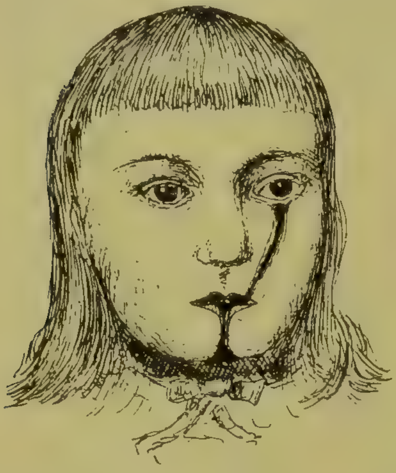

FIG. 240.
Facial and mandibular clefts.

Other still rarer malformations are the **mandibular cleft,** caused by want of fusion of the two mandibular processes, and the **facial cleft,** due to failure of union of the lateral nasal portion of the fronto-nasal process with the maxillary processes. The nature of these malformations is sufficiently indicated by the accompanying figure (fig. 240).

Hare-lip is a congenital malformation in which the upper lip is vertically cleft. Usually the cleft is on one or both sides of the median line, but a few cases have been recorded where the cleft has been in the middle line of the lip; these will be referred to later on.

The ordinary lateral hare-lip is due to a want of fusion of some of the fissures in the region of the fronto-nasal process. The usual opinion is that it is due to a failure of union of the fronto-nasal process—which it is believed forms the whole of the median portion of the lip—with the maxillary process, or processes if it is on both sides, which form the lateral portion; but this scarcely explains the fact that in most cases the cleft corresponds in position to the interval between the lateral and central incisors. Albrecht has suggested that both the mesial and lateral portions of the fronto-nasal process assist in the formation of the lip, and that hare-lip is due to the want of fusion of these two segments of the fronto-nasal process. A *simple* hare-lip is where the cleft is confined to the lip, and this may be *complete*, when it involves the whole depth of the lip and extends into the nostril; or *incomplete*, when it involves only a part of the depth of the lip. It may be *unilateral*, when it is confined to one side, most frequently the left; or *bilateral*, when it involves both sides. When the bony alveolus is also cleft, the term *alveolar* hare-lip is applied, and this may be either unilateral or bilateral. In the latter class of cases the central portion of the alveolar margin, the *os incisivum*, may retain its normal position, but is more often displaced forwards and rotated, so that the margin of the alveolus projects forwards. In some instances the nasal septum, to which it is connected behind, becomes elongated, and pushing the os incisivum forwards, this portion of bone, with the central portion of the lip, becomes attached to the under surface of the tip of the nose, entirely separated from the superior maxillary bone, and produces a most unsightly deformity (fig. 241). In these cases of bilateral alveolar hare-lip the deformity is complicated with fissure of the hard palate, which will be referred to in the sequel.

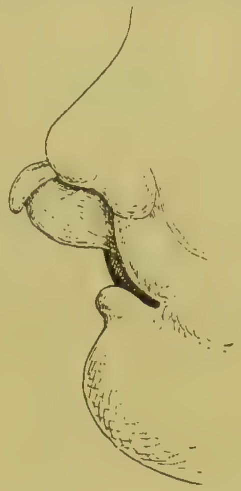
FIG. 241.—Double hare-lip, with protrusion of the os incisivum.

As regards the causation of hare-lip very little is known, except that it is, like most other deformities, very often hereditary and transmitted from generation to generation in the same family. It is frequently associated with other deformities in the same subject.

Simple hare-lip (fig. 242).—In simple hare-lip the cleft is on one side of the middle line, generally the left, and there is no other deformity. It usually extends from the nostril to the free edge of the lip. The nostril on the affected side is broadened and depressed. The two margins of the cleft are of unequal length, so that the halves of the lip lie on different levels in the majority of cases.

Treatment.—The only way of treating these cases is by an operation, which consists in rawing the edges of the cleft and bringing them together by sutures. There are several different modes of effecting this, some of which we shall describe; but before doing so, it is necessary to consider the age at which the operation should be undertaken. This may be broadly stated as being from six weeks to six months after the birth of the child. It should not be delayed longer, because after the first six months the infant is teething, and this may interfere with primary union of the wound. There is no necessity to operate before the age of six weeks, and it is desirable to wait until the child has become accustomed to an independent existence. With care, food can always be administered to a child, however severe a cleft palate and hare-lip it is suffering from. In simple hare-lip, when the fissure is confined to the lip, the child can generally take the breast; or if not the breast, a bottle provided with a large teat; but however extensive the cleft, I have never seen a case in which the child could not be fed by means of a spoon introduced into the back of the mouth, so that the milk is dropped into the pharynx.

In deciding the time between these limits of six weeks and six months, the surgeon must be guided by the vitality of the child. If the child is strong and robust, and takes its food well, the sooner the operation is performed the better, especially if the fissure is a simple one. In cases where the child is feeble and presents evidence of malnutrition, or where the operation will be of a complicated nature, it is better to defer proceedings till the third or fourth month of life.

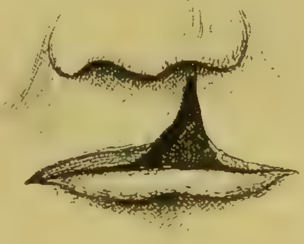
FIG. 242.—Simple hare-lip.

As union by first intention is to be aimed at in these cases, the surgeon should always be careful to note that the general health of the child is good, and that it is not suffering from any morbid condition, especially of the mouth or nose, which would interfere with union. If such conditions exist they must be cured before an operation is undertaken.

Of the many operations which have been devised for hare-lip, the one which has yielded the most satisfactory results in my hands in the majority of cases is that known as Mirault's, and this is the one which I almost always perform. The operation devised by Rose gives most excellent results in cases where the edges of the cleft are the same length, but unfortunately this is not often the case; and Nélaton's operation is useful in cases of incomplete cleft. These are the only three operations for the description of which space can be found in this book.

Mirault's operation.—The child is laid on its back on a table facing a good light, with the head and shoulders slightly raised. Chloroform is administered by an anæsthetist standing on the left-hand side of the patient. An assistant, standing behind the head of the child, inserts the forefinger of either hand into the corners of the mouth and compresses the superior coronary artery between the finger and thumb. Or these vessels may be compressed by Smith's self-retaining clips. The surgeon, standing on the right-hand side of the table, first everts the lip, and separates it thoroughly from the alveolus by dividing the reflection of mucous membrane and the frænum freely. If the ala of the nose is flattened, it must also be separated from its bony attachment. The extreme edge of the cleft is then to be seized with a pair of clawed dissecting forceps on that side of the cleft which is the shorter, i.e. the outer side, and an incision is made from the top of the cleft, within the nostril, obliquely downwards and outwards until it almost reaches the point of junction of the skin and mucous membrane; it is then sloped obliquely outwards, so as to raw the free margin of the lip (see fig. 243, A). On the opposite side of the cleft, the margin having been seized and put on the stretch with the forceps, an incision is made from the same point downwards and towards the middle line until it nearly reaches the point of junction of the skin and mucous membrane. By this means a flap is formed, which is to be turned downwards, as in fig. 243, B. A hare-lip pin is then introduced through the whole thickness of the lip on both sides of the cleft, on a level with the angle formed by the two lines of incision on the outer side of the cleft, and at the point of junction of the flap with the rawed surface on the inner side of the cleft. A twisted suture will now draw the edges of the cleft together, and the rest of the extent of the wound is to be accurately adjusted by horsehair sutures (fig. 243, C); care must be taken to suture the mucous as well as the skin surfaces. A small piece of gauze is twisted

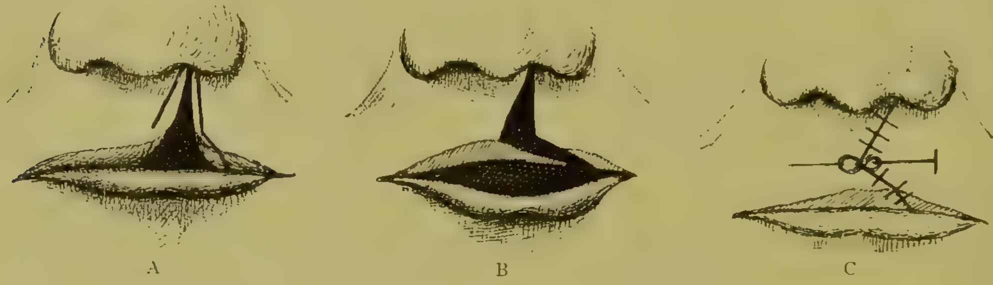

FIG. 243.—Mirault's operation for the cure of hare-lip.

under the pin, and the whole of the upper lip covered with two or three layers of gauze, fixed by collodion. The hare-lip pin is to be removed at the end of forty-eight hours; the superficial stitches may be left for a week.[1]

Most surgeons object to the use of hare-lip pins, and use instead silver wire; but I have always employed them, and have seen no reason to be dissatisfied with them. The main objection which it is stated that there is to their use, is that they leave a small scar at the site of puncture. If, however, they are withdrawn at the end of forty-eight hours, as they should be, they leave no mark, and they certainly possess the advantage of being rapidly applied, and of completely stopping the hæmorrhage from the coronary artery. However, if the surgeon prefers the silver suture, there is no real need for using the hare-lip pin; the only care should be to introduce the suture through the whole thickness of the lip down to the mucous membrane, otherwise bleeding may take place from the deep surface of the wound.

Rose's operation.—In cases where the two edges of the cleft are equal or nearly equal, the most satisfactory results may be obtained by the plan advocated by Rose, which is a modification of an old operation introduced by Syme. It consists in making an incision on either side of the cleft, in a semicircular manner, from its apex to the point of junction of the cutaneous and mucous surfaces of the lip, and from this point obliquely upwards into the cleft (fig. 244). The two little angular flaps formed at the extremity of the cleft are turned down and sewn together, so as to form a prolabium. Rose uses deep silver sutures, two in number, one just above the red margin and one close to the nose, and superficial horsehair or catgut sutures to accurately adjust the edges.

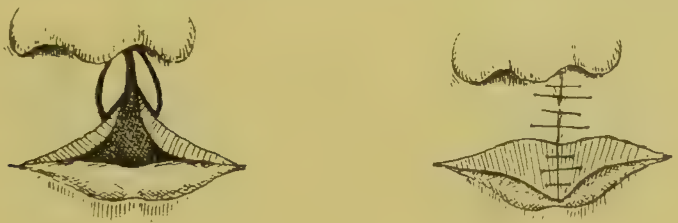

FIG. 244.—Rose's operation for the cure of hare-lip.

Nélaton's operation is only applicable to incomplete hare-lip, i.e. clefts which do not extend through the entire depth of the lip into the nose. It consists in making a reversed V-shaped incision round the top of the cleft, and then pulling the apex of the fissure downwards, so as

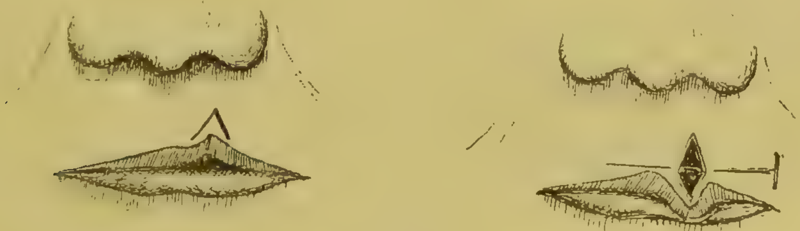

FIG. 245.—Nélaton's operation for the cure of hare-lip.

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[1] It should be mentioned that the operation above described is a modification of Mirault's. In his operation the flap is cut from the outer or shorter edge of the cleft. After extensively trying both plans, I have come to the conclusion that the one I have advocated gives the best results.

to form a diamond-shaped wound, the edges of which are then sewn together (fig. 245).

Double hare-lip.—In cases of double hare-lip the treatment must differ as to whether the hare-lip is simple, or whether it is complicated with clefts in the alveolus and projection forwards of the os incisivum. In the simpler cases the operation is to be conducted very much on the same principles as in single hare-lip. The outer edge of each cleft is pared, and the lateral borders of the central portion, and the edges of the lateral portions, are attached to the central piece above and to each other below, so as to form a line of union in the shape of a Y. The lines of the incisions may be planned either on the method of Mirault, leaving a flap on either side (fig. 246), or on the method of Rose. Both plans give admirable results.

When there is a cleft in the alveolus, and the os incisivum is displaced, it is a debatable point whether this portion of bone should be removed or not. After having tried both the plan of retaining the bone and bending it back into position, and removing it, in a large number of cases, I have come to the conclusion that there are very few cases in which better results will not be obtained by removing it, and this for two reasons. The central portion rarely if ever becomes united to the rest of the bone, but remains as a weak, mobile fragment, in which the incisor teeth are stunted, and usually displaced, so as to be useless for the purpose of biting; and secondly, because the replaced portion of bone prevents the edges of the cleft in the palate from approximating, which they would do otherwise, with the growth of the child, and so facilitate the future operation for the closure of the cleft palate. If the os incisivum is removed, as soon as the child has attained a sufficient age an artificial plate with incisor teeth can be adapted, with which he can bite, and by which the upper lip can be pushed forwards, and thus overcome the flatness which otherwise exists. In addition to this, there is a real danger, in forcing back the prominent bone, of fracturing the cribriform plate of the ethmoid by pushing up the nasal septum, to which the os incisivum is attached; so that if it is determined to retain this portion of bone, it should be replaced by cutting away a triangular piece of the nasal septum. Where it is determined to remove the bone, it should always be done a week or ten days before the operation for the cure of the hare-lip is undertaken. It can easily be snipped off with a pair of curved bone forceps, the superficial soft structures having first been separated from it. In doing this, an artery in the bone often bleeds freely, but usually stops with pressure, if a pledget of lint be held on it for a minute or two; if not, the application of a piece of wire heated to a dull red heat in a spirit lamp will at once effectually stop it. In these cases the nose is usually very much flattened, and care must be

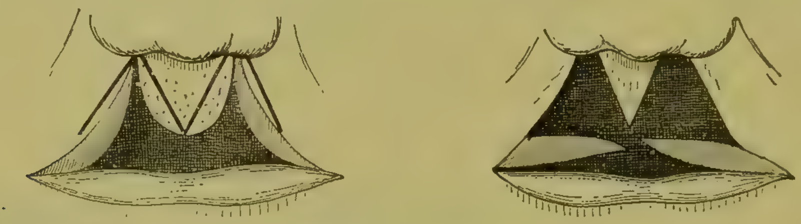

FIG. 246.—Operation for the cure of double hare-lip.

taken to separate the alæ of the nose freely from their bony attachments before proceeding to pare the edges of the cleft.

In those extreme cases where the central portion of the lip is attached to the tip of the nose (fig. 241), it is useless to attempt to form part of the lip from it, and the plan which I adopt is to cut away the os incisivum and a portion of the septum of the nose, and then turn up the central portion of the lip to form a new septum. The lateral edges of each cleft are then pared and united to each other in the middle line. If the soft parts, and especially the alæ of the nose, are freely separated from the bones beneath, this can generally be done, without such an amount of tension as will prevent union by the first intention.

In these complicated cases of hare-lip, after the operation there is a risk of asphyxia, from the tension of the upper lip and blocking of the nasal passages. I am in the habit, therefore, of inserting a small piece of indiarubber drainage tube into each nostril for some hours after the operation, through which the infant can breathe.

It is advisable after the operation to feed the child with a spoon, and this is what is generally done in hospital. In private practice, however, I usually allow the child to take the mother's breast from the first, and have never seen any harm arise from the proceeding.

Median hare-lip.—Occasionally, but very rarely, instances are met with where the cleft is in the middle line. Two varieties of this condition are met with. (1) The first is where there is a wide cleft due to absence of the whole of the præmaxillary bone, as well as the soft parts over it. These cases ought not to be classed as cases of median hare-lip. They are really instances of bilateral cleft with absence of the central piece. (2) The other more interesting condition is where there is a true cleft in the middle line. It is generally incomplete, but may be complicated with a bifid condition of the os incisivum. The deformity would appear to be due to failure of union of the two endognathia, or globular processes of His, of which the os incisivum is made up.

Hypertrophy of the lips.—True hypertrophy of the lips—*macrocheilia*—is a very rare condition; but there are other forms of enlarged lip which are usually termed hypertrophies, which are probably inflammatory in their nature, as the strumous lip and the syphilitic lip.

Macrocheilia is a congenital affection which may attack either or both lips. It is a condition of chronic lymphangiectasis, resembling macroglossia, which will presently be described, and consists in an increase in size and number of the lymphatic vessels and spaces, with overgrowth of the connective tissue. The lips become greatly enlarged, and feel firm and solid; when the lower lip is affected, it becomes everted and depressed from its own weight. The **treatment** consists in excising a wedge-shaped piece of the lip throughout its whole depth, and uniting the cut edges.

Strumous lip is of common occurrence, and occurs in tuberculous children. It commences as a fissure or crack in the lip, most frequently the upper, which sets up a chronic inflammatory process, attended at first by œdematous swelling and subsequently by the formation of a new fibroid material. In the early stages, while the swelling is still soft, relief may be afforded by curing the fissure and by the administration of cod-liver oil and iron; later on, when the growth becomes hard and firm, the condition is permanent. It has been advised under these circumstances to excise a wedge-shaped portion of the lip, but the deformity produced by the scar is almost as great as that produced by the enlargement.

Syphilitic lip.—Occasionally, in the tertiary stage of syphilis, the lower lip is the seat of a diffuse thickening, and becomes enlarged and hard. The case must be treated with iodide of potassium.

Superficial ulcerations on the inner surfaces of the lips are common in dyspeptic people. They are very painful when touched. They can usually be cured by the application of a point of lunar caustic. Cracks and fissures in the lips are also common, and are often due to exposure to cold. When neglected, they form deep and painful fissures, which are prone to bleed and difficult to heal. The favourite site is the middle line of the lower lip. They must not be mistaken for the fissures at the angle of the mouth in congenital syphilis. They can generally be cured by the application of nitrate of silver, but if they become persistent and chronic it may be necessary to remove the indurated margin before healing will take place. **Herpes** frequently attacks the lips as the result of catarrh, and also in febrile conditions. It also often occurs during the course of pneumonia. The lip becomes painful and swollen, and this is followed by a crop of vesicles surrounded by a red inflammatory zone. The vesicles become pustular, burst, and leave small scabs, which soon separate. No special treatment beyond the application of a little lanolin is required. **Cysts** are common in the lips, due to obstruction of the mucous follicles. They are small transparent thin-walled cavities containing a glairy fluid. The only treatment is excision of the whole of the sac wall, any partial operation, such as removal of a portion of the wall, being frequently followed by recurrence. The lips are very frequently the seat of **nævus.** The treatment varies with the extent of the growth. When small and situated on the margin of the lip, they may be cured by the application of nitric acid or ethylate of sodium ; when they involve the whole thickness of a small portion of the lip, they may be excised by a V-shaped incision, and the edges united ; but when, as is usually the case, they involve a considerable portion of the lip, they are best treated by repeated applications of the galvano-cautery. Occasionally they are found as more or less pedunculated growths, and it may then be possible to cure them by ligaturing the pedicle.

Carbuncle of the lip.—The so-called *facial carbuncle* almost always occurs on the lips, generally of young men, and is a most fatal disease. It begins as a vesicle or pustule, generally on the upper lip ; inflammation of the whole lip follows and spreads to the face. There is considerable constitutional disturbance, with a high temperature. Suppuration takes place in the course of a day or two, and small openings form which give exit to drops of pus. The skin then gives way, and soft shreddy sloughs are thrown off. During the whole of this time the constitutional symptoms are of the gravest kind, and are accompanied by great prostration. Septic thrombosis of the veins of the face occurs, giving rise to septicæmia and pyæmia. In many cases the septic condition in the veins spreads to the intra-cranial sinuses through the ophthalmic veins, and gives rise to septic meningitis. The exact nature of this condition has been the subject of some discussion, but most surgeons are in favour of its being a true carbuncle. It must not be mistaken for malignant pustule.

The **treatment** of this condition must be of the most active character ; as soon as the condition is diagnosed an anæsthetic should be administered, and free incisions should be made deeply in all directions in the inflamed tissues, and the parts thoroughly swabbed out with pure carbolic acid. The parts should then be covered with compresses of gauze soaked in

1 in 2,000 corrosive sublimate solution, which should be constantly changed. Quinine in five-grain doses should be administered three or four times a day, and as much stimulant and fluid nourishment as the patient can take should be given.

Syphilitic lesions of the lip.—Primary sores are not uncommon on the lips, being caused by kissing an individual affected with syphilitic stomatitis, or using the same drinking-cup or pipe. The main point in connection with these sores as they are found on the lips is that they, as a rule, do not present the same typical induration which an Hunterian chancre on the genital organs presents (fig. 38). There is usually swelling and widespread infiltration of the whole lip, and the neighbouring lymphatic glands are early affected. The condition is one, therefore, which is very liable to be mistaken for epithelioma.

The **diagnosis** may be made by attention to the following points. Chancre may occur at any age, but epithelioma is a disease of advanced life ; a chancre develops rapidly, an epithelioma slowly, on the top of some antecedent condition, as an abrasion, wart, &c. The chancre presents a smoother surface than the irregular excavated outline of epithelioma. It is usually painless ; epithelioma often very painful. The enlargement of the glands is different in the two conditions : in chancre of the lip, a crop of glands becomes enlarged all at the same time, shortly after the appearance of the sore ; whereas in epithelioma a single gland becomes first enlarged, and this is followed by another, but the enlargement does not begin for some time after the epithelioma has commenced. In addition to these signs, the advent of secondaries and the influence of remedies will at once establish the diagnosis.

In secondary syphilis, mucous plaques are frequently met with on the lips ; and in tertiary syphilis, in addition to the diffuse enlargement already alluded to, gummata, circumscribed in character, are occasionally met with in the lips.

Epithelioma.—Epithelioma of the lip is always of the squamous-celled variety, and, like many other forms of this disease, begins at the junction of the muco-cutaneous surfaces, as the result of some irritation. Of these, the most common cause would appear to be the irritation excited by smoking a clay pipe ; hence the disease is much more frequently met with in men than in women. It is said to be often seen among the labouring class of women in Glasgow, who are much addicted to smoking. Epithelioma also not infrequently attacks warty growths on the lip when they are irritated. These growths are common in this situation, and should always be removed, on account of this tendency that they have to become epitheliomatous.

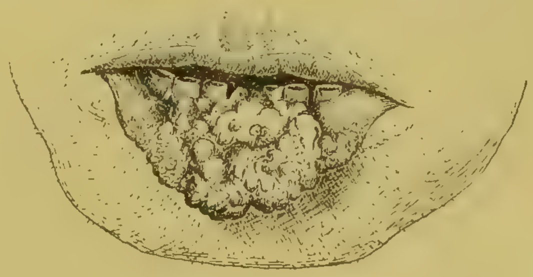
FIG. 247.—Epithelioma of the lip. (From a drawing in the Museum of St. George's Hospital.)

Cancer almost always affects the lower lip. It begins as a crack or fissure, or as a warty growth, which ulcerates and early involves the submaxillary glands. When fully developed it presents an ulcer with raised, everted indurated edges, and a sloughy, unhealthy-looking base (fig. 247). It shows no tendency to heal, but spreads superficially along the margin of the lip, and deeply into its substance. As it spreads, it involves the mouth and implicates the lower jaw. The submaxillary glands after a time break down and ulcerate, and the disease extends to the other glands in the neck, which cause large swellings in this situation. These, after they have ulcerated, form large sloughy cavities, which give rise to foul discharge and frequently bleed. The repeated hæmorrhages and absorption of septic poisons from the growth cause death from exhaustion and toxæmia. The disease rarely disseminates itself in the viscera.

Treatment.—The only treatment for cancer of the lip is free and early removal. This is usually best done by a V-shaped incision, cutting wide of the growth through healthy structures; the edges of the cut are then united by hare-lip pins, with figure-of-8 suture, or by silver wire sutures. In some cases, where the disease has spread principally along the free margin of the lip and has not implicated it to any very considerable depth, it may be necessary to remove a slice of the lip and then suture the mucous and cutaneous surfaces together. When the glands are already enlarged, the advisability of operating must depend upon the amount of enlargement and the fixity of the growth. When the glands beneath the sterno-mastoid and around the big vessels have become involved, the case is beyond the reach of the surgeon; but when the glands are confined to the submaxillary region, an attempt should be made to remove them if possible.

Epithelioma of the lip is a local disease and spreads solely by continuity of tissue, and therefore the prognosis after thorough removal is a favourable one if the disease is removed in the early stage. As a rule, if freely removed, it rarely returns; but unfortunately it very often happens that it is not removed until the submaxillary glands have become involved, though they may not be sufficiently implicated to form definite swellings, which can be detected through the skin. It is a matter of constant experience to see patients who apply for advice for a swelling in the neck, which proves to be a mass of malignant glands, by this time adherent and beyond the reach of the knife, and with the history that they had a sore removed from the lip some months previously. The cicatrix will be visible, sound, and without any evidence of recurrence. It seems to me, therefore, that the same rule should be applied in these cases as is adopted by most surgeons in removing a cancer of the breast, when it is the custom of most to clear out of the axilla all the lymphatic glands it contains. I would suggest that in every case in which a cancer is removed from the lower lip a free incision should be made in the submaxillary region, from the symphysis of the jaw to the hyoid bone, and back to the sterno-mastoid, and the whole contents of the submaxillary triangle removed. This would probably necessitate the division of the facial vessels.

INJURIES AND DISEASES OF THE MOUTH AND TONGUE

Wounds of the mouth may be the result of cuts made from without inwards, but most frequently are the result of gunshot injuries or punctured wounds from some pointed instrument introduced into the mouth. In the former class of cases, accurate adaptation and suturing of both mucous and cutaneous surfaces must be undertaken; in gunshot wounds the amount of lesion of the soft parts is usually of secondary importance to the injury to the skull and brain, and these injuries are generally fatal.

The tongue may be wounded by stabs, gunshot wounds, or by foreign bodies held in the mouth and driven into the tongue, but is most frequently injured by being caught by the teeth during an epileptic fit. These wounds often give rise to free hæmorrhage, but as a rule, being near the tip, it is an easy matter to seize the vessel and tie or twist it, and even when situated far back the bleeding point may be seized in a pair of clip forceps, which can be left on for a few hours, if the vessel cannot be tied, and this will usually arrest the hæmorrhage. In many cases of wound of the tongue it is not necessary to apply sutures—a somewhat difficult proceeding, as the tissues are so lacerable—for it readily heals; but in some cases, when a portion of tongue is almost separated, an attempt should be made to suture it by passing the sutures very deeply and using some non-absorbent material, such as a couple of pieces of horsehair, as one is scarcely strong enough to hold. Wounds of the tongue usually present a sloughy appearance for a few days, and during this time there is danger of septic pneumonia being set up, which must be combated by the free use of iodoform or Whitehead's varnish. After a day or two they become clean, and then granulate freely and heal. Occasionally the cicatricial contraction which subsequently takes place may materially interfere with the movements of the tongue, and with distinct articulation. Should a wound of the tongue not heal, the presence of a foreign body in it should be suspected and careful search made.

The tonsil may be wounded in thrusts through the mouth, as in the case of a tobacco-pipe held between the lips being driven backwards, and in these cases there is always a risk that the internal carotid or ascending pharyngeal artery may be wounded. The palate may also be wounded in the same way or from gunshot wounds. Foreign bodies, such as fish-bones, may become lodged in the soft palate, and may give rise to abscess and possibly secondary hæmorrhage. In cases of large wounds of the soft palate, careful suturing must be resorted to, as they have a great tendency to gape.

Scalds of the mouth are of common occurrence, especially among the children of the poor, from their attempting to drink out of the spout of a kettle of boiling water. They may also arise from taking too hot food, but these are rarely serious; or from swallowing corrosive or caustic materials, which are the most serious of all. The great danger in the first class of cases is not so much from the effects of the water on the mouth, but from the inhalation of the steam, which sets up a condition of œdema of the glottis. This will be considered later on. The interior of the mouth looks white; the child complains of great pain, and in some cases slight superficial sloughing may ensue, which may lead to contraction and interfere with the movements of the tongue.

Stings of insects.—Stings from wasps and bees are not uncommon in the mouth. They cause acute pain, often followed by rapid swelling of the tongue, which may impede respiration and threaten asphyxia, and may necessitate incision. This, however, is rarely required; the swelling usually begins to subside in a few hours, and generally rapidly disappears. The only treatment that is necessary is to wash out the mouth constantly with a solution of bicarbonate of potash or soda, which neutralises the action of the poison.

Cleft palate is a congenital deformity of the mouth due to want of union of the two palatal segments of the maxillary processes. It may be complete or partial. The *complete* form is where there is an entire separation of both hard and soft palate, extending forwards through the alveolar process, and complicated with single or double hare-lip (fig. 248). When it extends through the alveolar process, it generally lies in the fissure which runs between the central and lateral incisors, that is between the endo- and meso-gnathion, and the cleft may exist on one or both sides. More rarely it runs through the intermaxillary suture, between the lateral incisor and canine tooth, from failure of union of the maxillary and fronto-nasal processes. Rare cases have been recorded where it has been in the middle line, between the two central incisors. In the *partial* or *incomplete* form of cleft palate various degrees may be met with. The uvula alone may be bifid; or the cleft may extend through the soft palate; or the posterior part or the whole of the hard palate may be involved. Occasionally there may be a hole in the middle line of the posterior part of the hard palate, the anterior part of the hard and the soft palate being perfect.

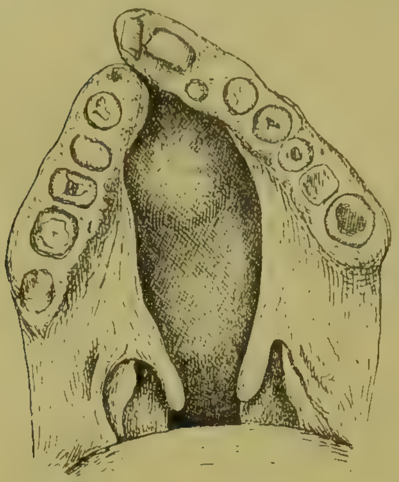
FIG. 248.—Cleft palate. (From a cast in the Museum of St. George's Hospital.)

Symptoms.—These deformities give rise to great inconvenience in deglutition and articulation. The first thing that is noticed is, that the infant is unable to take the breast, as it cannot form a vacuum in the mouth. Unless fed artificially, it must of course therefore perish from inanition. Later on, when the child begins to swallow, it will be noticed that there is a great tendency for the food, especially fluids, to return through the nose. The child may, however, after a time, learn to overcome this difficulty. The edges of the cleft become approximated during deglutition, and if the act of swallowing is performed slowly and carefully, the regurgitation of fluid may be prevented. As soon as the child begins to speak, the voice exhibits the characteristic intonation of these cases; it is nasal, indistinct, and very unpleasant.

Treatment.—The treatment of cleft palate consists in attempting to close the cleft, and this may be done by operation or by means of an artificial obturator. Before considering these two plans, it is necessary to say a word or two about the immediate treatment of the infant after birth, for, being unable to suck, it has to be fed artificially. The best food is the mother's milk, which may be drawn off periodically and given to the child. The mode of administering it is a matter of some importance. If the cleft is only partial, i.e. confined to the posterior part of the palate, the child may be enabled to suck by using an ordinary bottle with a large teat, or a teat with a leaflet of indiarubber attached to its upper surface, which fills up the cleft. If this cannot be done, there are two plans of feeding it, either by one of the old boat-shaped bottles, by which the milk is *poured* down the child's throat without suction, or by means of a teaspoon. Of the two I decidedly give preference to the latter, if only a nurse can be obtained who will devote sufficient time and patience to feeding the child in this manner. If the milk is given with the bottle, it is given too quickly, and rapidly distends the stomach, and is liable to be rejected; whereas, if it be given with a teaspoon, it must be given slowly, and more exactly imitates the natural process of sucking.

On account of the difficulties of the operation for closing a cleft in the palate, and the frequent failures which take place, many surgeons have recommended that an obturator should be adapted to the cleft in the hard palate, which would close it, and to which a flexible india-rubber leaflet should be attached, to take the place of the soft palate. They believe that more satisfactory results can be obtained by this means, and several varieties of obturators have been devised. But there are many objections to their use in children. In consequence of the constant growth in the mouth of the child, they require renewing frequently; they have to be fixed to the teeth, which they destroy and displace; by being wedged into the cleft they have a tendency to increase its size, and if not accurately fitted they often produce ulceration. The use of obturators should therefore be confined to adults, and to those cases in which operations, perhaps more than once, have been undertaken and have failed.

In the vast majority of cases it is advisable to attempt the closure of a cleft palate by operation. And the first point to consider is the best age at which to make the attempt. Some difference of opinion exists on this point, and something must depend upon the general condition of the patient and the extent of the cleft.

In the young infant the operation should clearly not be undertaken; it is one of severity, is sometimes attended with considerable loss of blood, which the young infant is ill prepared to stand, and will often prove unsuccessful. Many surgeons, however, recommend operation at the age of twelve months. For my own part, I do not think operations at this age are desirable. There is no real necessity for them, for if the child has been reared to this age, it is probable that there will be no difficulty in continuing to maintain its nutrition. I think the operation should be delayed as long as possible, and this for two or three reasons. The older the child is, the better able he is to withstand the operation; the longer he lives up to a certain date the smaller will be the cleft which has to be closed, for during the first two or three years of life the palatal segments of the maxillary process, in a case of cleft palate, have a tendency to grow inwards and partially narrow the cleft; and thirdly, the muco-periosteum covering the palate tends to thicken as the child grows, and thus forms a more substantial and more vascular flap. I have seen many cases of cleft palate where the muco-periosteum in young infants was exceedingly thin and almost diaphanous, who a year or two afterwards have had a thickened structure well adapted for operation. When, however, a child attains the age of two and a half or three years, he begins to speak, and then a real necessity for operation arises; for if he is once allowed to acquire a nasal intonation, it will be found an exceedingly difficult thing to eradicate it. The time, therefore, that I recommend, as a rule, for the operation is about the age of three years, or as soon as the child begins to speak. In some cases where the child's nutrition is very defective, or where the cleft is a very wide one, it may be prudent to wait even longer than this.

Operation.—Two different names have been given to the operations for uniting a cleft in the palate: where the soft palate only is cleft and requires operating upon, the term *staphylorraphy* is applied; but where the hard palate is the part involved, the operation of closing it is called *uranoplasty*. So that when both hard and soft palates are involved, the complete operation for closure would be uranoplasty and staphylorraphy. It is the usual practice to deal with the two conditions at the same time when it can be done, but there are some cases where there is a very wide gap in front, owing to the removal of the os incisivum, in which it is impossible to bring together the anterior parts of the cleft. These cases are best dealt with by operating on as much of the cleft as possible, leaving a gap in front, which can be easily closed by the plate to which the artificial incisors are attached, or may be dealt with at a subsequent operation.

During the operation the child is placed in different positions by different operators. Some prefer to place the child with the head falling backwards over the end of the table; others prefer to operate with the head turned to one side; and others prefer the child to be placed on its back, with the shoulders slightly raised, so that the head falls back. This latter is the position I have always adopted, as by it a better light and view of the parts in the mouth can be obtained. Chloroform should be administered, as ether tends to increase the secretion of the saliva and mucus in the mouth, and obscures the operator's view of the part. As soon as the child is under the influence of the anæsthetic, the gag should be inserted and held by an assistant standing behind the head of the patient. Several forms of gag are in use by different surgeons, but the one which in my hands has proved most efficient is the one which was invented by Sir Thomas Smith, who was the first surgeon to undertake the operation of cleft palate under an anæsthetic. Care must be taken, however, that the gag fits, and that the tongue is not pushed back by the tongue plate, so as to roll over the entrance into the air passages and obstruct the breathing. The assistant who holds the gag should be instructed to turn the child's head over to the side in each pause in the operation, while more chloroform is being given, so that the blood may run out of the mouth.

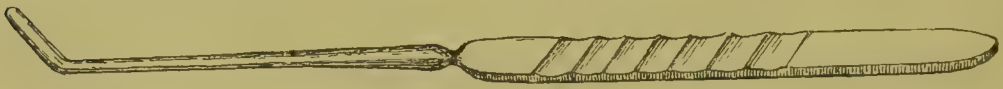

FIG. 249.
Elevator for separating the muco-periosteum in the operation for cleft palate.

The first step in the operation consists in paring the margins of the cleft. This is done by seizing the extreme edge with a pair of clawed spring forceps, introducing a tenotome on a long handle through the palate, just external to the point seized, and cutting off a thin slice in one piece from one end of the cleft to the other. In a similar way a thin slice is cut off the other side, care being taken to include the anterior angle of the cleft.

The second stage of the operation consists in bringing down the muco-periosteum. The point of the knife is introduced through the mucous membrane just internal to the last molar tooth, and carried forwards so as to divide all the structures down to the bone, as far as the position of the canine tooth. The process is then repeated on the other side. A suitable elevator (fig. 249) is now introduced through the incision, and by a rotatory movement of the instrument the muco-periosteum is stripped off the bone on both sides. When this has been done as far as possible, it will be found that the soft parts do not fall away from the bone, because the soft palate is still connected to the posterior margin of the hard by the mucous membrane and other soft structures passing from the floor of the nares on to the posterior surfaces of the soft palate. These must therefore be divided. The elevator is introduced through the incision and is made to depress the muco-periosteum from the bone, so that one blade of a pair of curved scissors can be introduced between the two; the other blade is inserted on the posterior surface of the soft palate, close to its junction with the hard, and the structures between the blades divided by cutting outwards. When this has been done on both sides, the two flaps of muco-periosteum will fall like curtains. If the child was completely anæsthetised when the operation was commenced, and the proceedings described have been performed quickly and without any hitch, it will generally be found that these two stages of the operation can be completed before the child gives evidence of recovery from the chloroform. The child's head should now be turned over to one side, and the hæmorrhage, which is always pretty free during the stripping down of the flaps, arrested. This may generally be done by syringing cold iced water through the nostrils. This not only arrests the bleeding, but also clears away the clots without sponging, which is to be avoided as much as possible, as it tends to bruise the edges of the incision and to prevent clotting in the vessels. During this time the child has been recovering still further from the anæsthesia, and it is well to let it do so, as with returning consciousness it will expel any blood which may have found its way into the air passages.

As soon as all bleeding has ceased, some more chloroform may be given, and the head having been turned back, the third stage of the operation may be commenced. This consists in passing and tightening the sutures. Silver sutures should be used for the hard palate and anterior part of the soft palate, and horsehair for the uvula and posterior part of the soft palate. The best form of needle for the introduction of the sutures is the tubular needle invented by Sir Thomas Smith (fig. 250); by means of this instrument the suture can be introduced at once through both flaps of the palate. In doing this great care must be taken not to bruise the edges of the cleft, and on no account should they be seized, as is so often done, with a pair of forceps in order to steady them while the needle is being passed. The only difficulty is with the first suture, but by a little manœuvring this may be introduced, and then being held in the left hand it tenses the flaps, and the rest of the sutures can be passed without difficulty. When all the silver wires have been inserted, they are tightened to a sufficient degree to bring the edges of the cleft into contact, and are then twisted with a wire twister, care being taken not to twist them so tightly as to strangle the tissues. One or two horsehair sutures are now to be introduced into the posterior part of the soft palate and uvula, with a needle on a handle bent at a right angle, and tied.

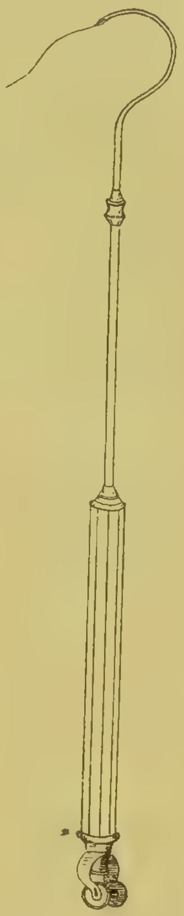

FIG. 250.—Smith's tubular needle for inserting the sutures, in the operation for cleft palate.

The final stage of the operation consists in making lateral incisions to relieve tension. This is easily done by continuing the lateral incisions, already made, backwards through the soft palate, and this should be done until the palate hangs quite flaccid, and there is not the slightest tension on the stitches. The whole success of the operation depends upon this being done thoroughly, and no fear need be felt about the wounds not healing, as they always appear to do so.

Two other methods of operating in a cleft of both hard and soft palate have been introduced, but as far as I am aware they are not often practised, and it is scarcely necessary therefore to describe them. (1) Fergusson's plan consists in dividing the bone of the palate longitudinally with a chisel and prising it inwards until it reaches the middle line, where it is united by sutures to the bone of the opposite side, similarly displaced. (2) Davies-Colley's plan consists in transplanting a flap of muco-periosteum across from one side to the other. It is recommended in cases where the cleft is too wide to be united by the ordinary method, or in those where this method has failed.

In those cases where the cleft is confined to the soft palate, the operation consists in performing staphylorraphy alone. This comprises paring the edges, uniting them by horsehair sutures, and making lateral incisions to relieve tension, in the manner described in the complete operation.

The after treatment must be conducted with care. No food should be given until all vomiting has ceased, and then nothing but milk, and later on beef tea which has been strained. No bread or solid food of any sort should be given, as crumbs are very likely to become lodged in the wound. The child is to be kept as quiet as possible, and prevented from crying, or if old enough from talking. The mouth should be washed out after each meal with weak Condy or Sanitas if the child is old enough to do so. No inspection of the wound should be made for a week, as the effect of opening the mouth wide is to put a strain on the sutures. The stitches should not be removed for ten days or a fortnight.

Results.—The result of the operation for cleft palate, as far as articulation is concerned, is not in some cases so favourable as could be wished, while in others it is most satisfactory. This is mainly due to the amount of stretching to which the soft palate has to be subjected in order to bring the cleft surfaces together. In some cases, where the segments of the palate are almost vertical and the arch of the palate very high, when the muco-periosteum is separated, the flaps fall considerably and meet easily in the middle line; under these circumstances the soft palate is flexible, and can be easily drawn up so as to close the posterior nares; under these conditions the nasal intonation is entirely, or almost entirely, lost. In those cases, however, where the segments of the palate are more or less horizontal, when the soft parts are separated from the bones and brought together, they are tightly stretched, and under these circumstances the velum cannot be raised to shut off the posterior nares, and the nasal intonation still persists. In spite of this, the patient derives considerable comfort and advantage, in other respects, from the operation; the food no longer has a tendency to find its way into the nasal cavities, and the senses of taste and smell are much improved.

After the operation for cleft palate a great deal may be done to improve the intonation by careful and systematic training. Immediately after the operation it will be found that there is little or no improvement in the voice, and it is only gradually and by careful training that the child can be taught to enunciate its words distinctly.

Stomatitis, or inflammation of the mucous membrane of the mouth, is a common affection, and occurs under several different forms.

Simple stomatitis may arise from many different causes, such as the irritation of a jagged or carious tooth ; the constant ingestion of hot foods, strong condiments, or raw spirits ; the fumes of tobacco smoke and other chemical irritants ; or it may be associated with disturbances of the digestive organs ; or, finally, it may arise in the course of fevers, especially the exanthematous in children. The disease is characterised by increased redness and swelling of the mucous membrane, which becomes œdematous and indented by pressure against the teeth : there is an increased secretion of a viscid character, and sometimes salivation. There is a clammy feel about the mouth, sometimes pain on taking hot food, a nasty taste, and foul breath. The epithelium covering the mucous membrane becomes white and sodden, and in some cases there is superficial ulceration. The treatment consists in frequently washing out the mouth with some mild antiseptic mouth-wash, as boric acid or chlorate of potash (gr. x to ℥j), and administering chlorate of potash internally. The diet should be fluid, consisting of milk, beef tea, &c.

Ulcerative stomatitis is a further development of the simple form, and in many cases occurs from the same causes in persons of unhealthy constitution, or who are crowded together under bad hygienic conditions. It may also arise from septic forms of inflammation following injuries or operations about the mouth. The early symptoms are much the same as in the simple form, but there is more swelling and great pain, so that taking food is almost impossible. The mucous membrane presents greyish sloughy patches ; the gums are swollen and recede from the bone, exposing it, and they bleed on the slightest touch. There is profuse salivation, and the breath is fœtid. The constitutional symptoms are severe, and are accompanied by great exhaustion. The **treatment** is the same as for the simple form, but great attention should be paid to the hygienic surroundings of the patient, and change of air is often followed by the happiest results. Tonics, especially quinine, and stimulants must be given where there is debility.

Aphthous stomatitis occurs mainly in infants and ill-fed children. In this condition, in addition to the diffused general stomatitis, there are whitish, slightly raised patches on the mucous membrane, surrounded by an inflammatory zone ; this is due to fibrinous exudation into the superficial layers of the mucous membrane and a degeneration of the epithelium. As the epithelium is shed, superficial ulcers are formed, which may become more or less confluent. The **treatment** must consist in attention to the general health. The milk which is given should be absolutely pure, and it is often of advantage to change the source of supply, as it is believed by some that the disease may be caused by the milk from diseased cows. The mouth should be constantly washed out with chlorate of potash or boric acid lotion and borax and honey, or the glycerine of borax may be used.

Thrush is a very analogous affection to the foregoing, but should be carefully distinguished from it, as it arises from a distinct and special cause—the parasitic fungus (*Oïdium albicans*). This fungus is found in acid milk, and the saliva of the child is also acid. The treatment is the same as for the aphthous form, except that no sugar should be given, as this is a favourite food for the fungus on which it flourishes.

Specific stomatitis may be the result of a mercurial, syphilitic, or scorbutic condition. **Mercurial stomatitis** may be due to the excessive administration of mercury, or to some idiosyncrasy on the part of the patient which renders him susceptible to the drug. Individuals who are the subjects of Bright's disease are peculiarly liable to be affected with stomatitis from taking mercury; a single dose being often sufficient to set up the condition. In severe cases there is swelling and sponginess of the gums, fœtor of the breath, and profuse salivation. In order to avoid stomatitis in patients taking a course of mercury, the teeth should be carefully cleansed and the mouth washed out several times a day. If the condition is set up, the drug should be stopped or the dose materially diminished. The mineral acids, with chlorate of potash, should be given internally, and the patient sent out in the fresh air as much as possible.

Syphilitic stomatitis.—In the early stages of secondary syphilis there is often a general stomatitis, accompanied by the formation of *mucous plaques*. These are small white or greyish white patches, due to a superficial inflammation, with degeneration of the epithelium. The patches are raised, and surrounded by an inflammatory zone. It must be borne in mind that these patches are infective, and therefore great care must be taken that the cups, spoons, &c., used by the patient are carefully cleaned and kept exclusively for his use. The **treatment** of these cases must be the ordinary constitutional treatment of syphilis. Mouth washes of borax or bicarbonate of soda should be used.

Scorbutic stomatitis is rarely seen in this country. It is a severe form of inflammation, accompanied by ulceration and sometimes gangrene. The teeth become loosened and drop out, and the alveolar portion of the jaw becomes necrosed. The **treatment** consists in administering anti-scorbutic remedies, and in constantly washing out the mouth with dilute antiseptic lotions.

Tumours of the mouth.—Tumours of the mouth, other than those of the tongue and jaws, which will be considered later on, are principally cystic in their nature, and are found in the floor of the mouth. Of the solid growths, angiomata are the most common of the innocent growths, and epithelioma of the malignant, but occasionally lipomata and adenomata of the salivary glands are found in this situation.

Of the cystic tumours, **ranula** is the most common. This is a cyst the exact pathology of which has been the subject of considerable controversy. There would appear to be certainly two and perhaps more causes to which this cystic swelling is due. There can be no doubt that in the majority of cases it is a retention cyst of one of the mucus-secreting glands in the floor of the mouth, especially of a gland which is situated near the apex of the tongue on either side of the frænum, and which was first described by Blandin and Nuhn; in certain cases, however, it is not due to this cause, but is the result of a dilatation of Wharton's duct, the orifice of which has become occluded. It has been stated also that ranula may be caused by an enlargement of a bursa which lies on the genio-hyo-glossus muscle on either side of the frænum, and by others that it may be due to dilatation of the duct of Bartholin, one of the ducts of the sub-lingual gland. The cystic tumour forms a swelling in the floor of the mouth, generally to one side of the middle line; it is globular, semi-transparent, and may attain the size of a bantam's egg, pushing the tongue upwards and backwards, and interfering with deglutition and speech. It contains a glairy, mucous fluid. The **treatment** consists in excising a portion of the anterior wall of the cyst, and then stuffing it with pieces of lint which have been steeped in a saturated solution of sulphate of copper and then dried, or by rubbing the remains of the interior of the cyst with lunar caustic.

Dermoid cysts in the floor of the mouth may be found in two situations; either in the median line, between the two genio-hyo-glossi muscles, where they are probably due to a dilatation of an unobliterated portion of the thyro-glossal duct; or to one side of the middle line, on the outer side of the genio-hyo-glossus, when they owe their origin to the inclusion of a piece of epiblast in connection with the formation of the structures in the floor of the mouth. They form rounded, smooth, elastic swellings, which can be distinguished from a ranula by their deeper position, as they are always situated under the mucous membrane, which can be pinched up from them and is normal in appearance. Though they are congenital, they may remain small and be undiscovered until adult age, when they may begin to increase suddenly and may attain the size of a bantam's egg. They present the ordinary structure and contents of dermoid cysts (page 229). The **treatment** consists in making an incision in the median line of the submaxillary space and dissecting out the cyst.

Other forms of cysts which sometimes project into the floor of the mouth are hydatid cysts, and enlargement of the bursa between the genio-hyoid and the genio-hyo-glossus. The latter, however, more usually projects in the neck, forming a fluctuating swelling in the sub-maxillary triangle.

Salivary calculi, consisting of phosphate and carbonate of lime, may form in any of the salivary ducts, but most commonly occur in Wharton's duct. They cause retention of the saliva, and the gland becomes swollen and painful upon taking food. They can at once be detected by passing a probe down the duct. The treatment consists in making an incision through the mucous membrane over the duct and prising out the calculus.

DISEASES OF THE TONGUE

Tongue-tie is a rare condition, though anxious mothers constantly consult the surgeon under the belief that their child is tongue-tied. When the condition really exists, the frænum is so short, and attached to the tongue so far forwards, that this organ cannot be protruded beyond the front teeth; when it can, there is no need for operative interference. In those cases where there is true tongue-tie, it may interfere to a certain extent with sucking, and later on with distinct articulation. Under these circumstances the frænum should be divided. This little operation is performed by introducing two fingers of the left hand, one on either side of the frænum, and pushing the tongue out of the way; a nick is made in the anterior border of the frænum with a pair of blunt-pointed scissors, and the tongue is forcibly pulled upwards by the two fingers and the rest of the frænum torn through. The cut should be made downwards to avoid wounding the ranine artery.

In rare cases the frænum of the tongue is too long, and under these circumstances the tongue may be sucked or fall backwards during sleep over the opening into the air passages. Death from asphyxia has been recorded from this cause.

Hypertrophy of the tongue (*Macroglossia*).—This is not a true hypertrophy of the tongue, but is a condition which is set up by some obstruction to the lymphatic circulation at the base of the tongue.

In consequence of this the lymphatic vessels and spaces become dilated and distended with lymph, and secondarily there is a diffuse overgrowth of the connective tissue with atrophy of the muscular fibres. The disease is usually congenital, though it may not be sufficiently pronounced to be observed at birth, but during the first year of life the tongue becomes so enlarged and prolapsed from the mouth that the child cannot close the jaws, and there is constant dribbling of the saliva. The exposed tongue becomes purplish, dry on the surface and often superficially ulcerated, but there is very little pain. The pressure of the tongue causes displacement of the teeth, and very often deformity of the jaw, pushing the alveolar process forwards.

Treatment.—When the tongue is so far enlarged as to protrude from the mouth, no treatment short of operation is likely to be of any avail. The operation consists in the removal of a V-shaped piece, with the apex directed backwards, and uniting the side flaps by sutures in the middle line. The results of the operation are usually very satisfactory. The bleeding is not excessive, and the risk is therefore small. The only point in connection with the operation is that it should not be delayed until the teeth have become displaced, as this condition cannot be remedied. Enlargement of the tongue may occur in the adult as the result of inflammation, and also in tertiary syphilis from the diffusion through it of numerous small gummata, but neither of these conditions is a true hypertrophy.

Atrophy of the tongue may result from nerve lesion; this condition is usually unilateral.

Acute glossitis.—Acute parenchymatous inflammation of the tongue may arise from several causes: from the introduction of some septic matter, from the bite of an insect, or from injury; from burns or scalds; during the course of some of the specific fevers, as an accompaniment of general stomatitis; or from the immoderate administration of mercury. The advent of the disease is sudden, and is attended by rapid swelling, so that the tongue is protruded from the mouth. The swelling is so great that the base of the tongue fills the pharynx, and may threaten suffocation and render speech and the taking of food impossible. The protruded tongue is red, acutely painful, and often presents on its surface superficial excoriations. The salivary glands are often involved, being swollen and painful, and there is profuse salivation. The constitutional symptoms are those of fever of an asthenic type, with a high temperature. As a rule the disease subsides under treatment, but occasionally it may run on to diffuse suppuration and death from septicæmia or septic pneumonia, or a circumscribed abscess may form.

Treatment.—The treatment consists in making a free longitudinal incision into the substance of the tongue on either side of the middle line. This is followed by immediate relief, though a certain amount of swelling may persist for a time. If asphyxia is threatened, it may become necessary to perform laryngotomy. In less severe cases, especially those arising from mercurial poisoning, incisions may not be needed; by stopping the drug and administering a saline purge, and washing out the mouth constantly with a chlorate of potash gargle, the swelling will usually subside.

Abscess of tongue.—Acute inflammation of the tongue may terminate in abscess; but in addition to this chronic abscess is occasionally met with. It forms a smooth, round, circumscribed swelling in the substance of the tongue, which has been mistaken for gumma and cancer. It is probably due to the introduction of some septic matter, through a puncture, from a fish-bone for example. The treatment consists in laying the abscess freely open, when it will heal up in a few days.

Chronic superficial glossitis.—Inflammation of the mucous membrane of the tongue is a disease of common occurrence, which has attracted considerable attention of late years. Its **etiology** is still involved in a certain amount of obscurity, but it would appear that there are several causes which may give rise to this condition. Formerly it was believed that syphilis was the only cause, but, more recently, excessive smoking and the habit of drinking spirits, especially undiluted, have been regarded as potent causes of this condition. There can be little doubt that one of these factors alone may excite the disease, but what is more probable in most cases is that more than one of them is concerned in its production; such as excessive smoking in a syphilitic subject, or excessive smoking and the drinking of raw spirits combined. Four distinct conditions are included under the term *chronic superficial glossitis*: (1) The initial condition, the red glazed tongue; (2) leucoplakia; (3) psoriasis; (4) ichthyosis; but it seems probable that they are only different phases of the same condition, for several of them may be present in different parts of the same tongue. (1) The *red glazed tongue* is the initial condition, and consists in a hyperæmia of the mucous membrane and sub-mucous tissue. In consequence of this the tongue is somewhat swollen and its mucous membrane becomes stretched, so that the tongue is red, smooth, and glazed. The condition is a very chronic one, and gives rise to no symptoms beyond a slight smarting on taking any hot liquid or hot condiments. It may last for years without undergoing any alteration, or it may pass on to the second condition, *leucoplakia*. This is most frequently the direct sequel of the red glazed tongue; but there is good reason to believe that it may sometimes be developed without being preceded by it. It does not affect the whole area of the dorsum of the tongue, but occurs in patches, as thickened epithelium. This is due to the inflammation of the mucous membrane causing an overgrowth of the epithelium, which becomes heaped up and forms plaques or patches, which become rough, dry, and horny. (3) *Psoriasis linguæ.* After the patches have formed and acquired a considerable thickness they become cracked or fissured, and present an appearance very similar to psoriasis palmaris, and hence the name. (4) *Ichthyosis.* A further stage is where the patches coalesce and the dorsum of the tongue becomes covered with thick warty masses of epithelium, and is hard and stiff, and often presents numerous cracks.

Symptoms.—In the early stages of the disease there is only a little discomfort on taking hot food. Later on this becomes increased, and speech may be interfered with. Occasionally some superficial ulceration of the patches may take place, and then the pain is considerably increased. The disease is exceedingly chronic and may go on for years, and at the same time it is exceedingly intractable and difficult to cure. It derives its chief clinical importance from the fact that it frequently terminates in epithelioma. Cases should therefore be carefully watched, and active measures adopted at once if this disease is set up.

Treatment.—The treatment is unsatisfactory as far as the cure is concerned, though much may be done to prevent the condition getting worse. Smoking must be rigidly prohibited. Stimulants should be interdicted, and all hot condiments and spices. The diet should be plain and nutritious. The mouth should be washed out after every meal with a solution of bicarbonate of potash (gr. xx to ℥j), and the teeth brushed. Dilute chromic acid and concentrated lactic acid have been recommended as local applications, but sometimes appear to aggravate the disease. Internally the administration of arsenic appears to do good, and in syphilitic cases antisyphilitic remedies must be exhibited. In these latter cases I have found the internal administration of Donovan's solution—liquor arsenii et hydrarg. iodidi—with a powder consisting of grey powder five grains, and compound tragacanth powder fifteen grains, to be placed on the tongue once a day, the best means of treating these cases. The powder forms a paste with the saliva, and gradually dissolves. While doing so it is to be kept in contact with the diseased surface.

Annulus migrans.—Another condition of the tongue has been described, occurring principally in children, but also sometimes in adults. It commences as small round spots of light-coloured appearance, which rapidly develop into a more or less complete circle, and spread centrifugally over the tongue. It is not very painful, but causes a sensation of itching, and is attended with increased salivation. It bears some resemblance to ringworm, but is not apparently due to a parasite. The disease is very chronic in character, may disappear for a time, and then reappear. No treatment appears to have any effect on it.

Ulceration of the tongue.—The varieties of ulcer to which the tongue is liable are the irritable, the dyspeptic, the tuberculous, and the syphilitic. (1) *Irritable ulcers* are usually caused by the irritation produced by a jagged tooth. They are therefore situated on the side of the tongue, and are often very painful. The treatment consists in extracting or filing the tooth. (2) *Dyspeptic ulcers* are usually multiple, and situated on the dorsum and sides of the tongue. The ulcers are circular and superficial with an inflamed area around. They are not indurated; are very painful, especially during mastication. The treatment consists in correcting the state of the digestive organs, and touching the ulcers with nitrate of silver. (3) *Tuberculous ulcer* is a rare disease which has only been recognised of recent years. It is generally secondary to tuberculous disease of the lungs or larynx, the organ being infected by the sputum. It consists in an isolated mass of tubercle, which caseates and breaks down, forming an irregular ulcer, generally on the under surface or sides of the tip of the tongue. The edges are sharply defined, the base nodular and uneven, and it is exquisitely painful, often causing intolerable suffering. **Treatment** must be directed to relieving the pain, since the disease is incurable on account of the constitutional condition. If this is very severe, the ulcer should be freely scraped, which will do much to relieve the pain. It has been advised in some of these cases to resect a portion of the lingual nerve. In less painful cases the local application of iodoform and morphia, and the administration of cod-liver oil, are indicated. (4) *Syphilitic ulcer* of the tongue is one of many forms of syphilitic affections of this organ, which it is more convenient to consider together.

Syphilitic affections of the tongue may occur in primary, secondary, and tertiary syphilis. In the *primary disease* a syphilitic sore or chancre is occasionally found on the tongue, though not so commonly as on the lips. It is much more common in the male than the female, and the infection would appear to be due, in most cases, to smoking the pipe of a person affected with syphilis. The sore presents the ordinary characteristics of a chancre, it soon becomes indurated, and is associated with enlargement of the submaxillary glands. It speedily heals under the influence of mercury. In *secondary syphilis*, mucous plaques, such as are found in syphilitic stomatitis (page 186), occur on the tongue, and also sometimes superficial ulcerations; they are usually multiple, roundish, with greyish bases, and sharp-cut edges. They are very painful, and are generally associated with similar sores on the lips, palate, and tonsils. Occasionally wart-like condylomata are found on the tongue in secondary syphilis. *Tertiary syphilis* shows itself in two ways in the tongue. One of these is where the tongue becomes enlarged by the diffusion through it of numerous small gummata; the other is much the more common, where the infiltration is localised, and gives rise to a definite gumma, which breaks down and forms a tertiary syphilitic ulcer. The disease usually commences in the muscular substance of the tongue near its centre, though occasionally superficial gummata form in the submucous tissue. The swelling is at first hard and firm, and usually appears about the centre of the dorsum of the tongue, a little to one side of the middle line. The swelling increases steadily if left untreated, and gradually softens. The mucous membrane, which up to this time has remained normal in appearance, now becomes involved and gives way, leaving an ulcer, which is usually oval or elongated, with sharp-cut undermined edges, and containing an adherent slough of the characteristic wet wash-leather appearance (fig. 40). There is usually little induration around at first, but in a tertiary ulcer which has been allowed to remain untreated a certain amount of induration may be found. In these cases, which are the ones most liable to be mistaken for malignant disease, the structures in the floor of the mouth are not implicated, so that the tongue can be protruded freely, and there is little or no interference with deglutition or articulation.

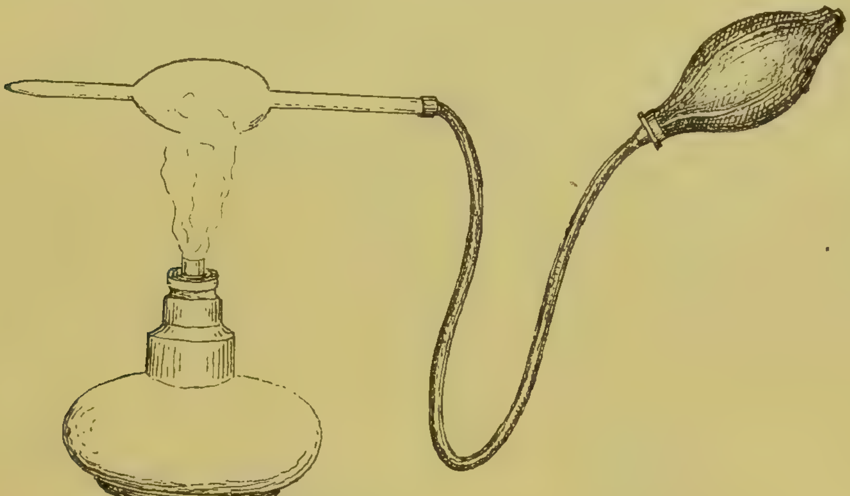

FIG. 251.—Apparatus for local calomel fumigation.

Under treatment a gumma of large size may be absorbed without softening and breaking down; and if this has occurred before treatment is commenced, the ulcer heals readily under antisyphilitic treatment, leaving a deep linear cicatrix.

Treatment.—Most cases of tertiary syphilitic ulceration of the tongue yield to the influence of iodide of potassium, if given in full doses. The healing is, however, very often hastened by the local fumigation of calomel.

This can be easily applied by means of a glass tube, with a bulb, in which the calomel is placed. To one end of the tube an india-rubber ball is attached, and the calomel having been sublimed by a spirit lamp placed under the bulb, the ulcer can be readily sprayed with the vapour (fig. 251).

Tumours of the tongue.—Innocent tumours of the tongue are occasionally met with, but the most common form of tumour is epithelioma. Among innocent growths, probably **nævus** is the most common. They are usually of the cavernous variety, and are often situated deeply in the substance of the organ. They rarely cause much inconvenience unless they attain a large size. The best mode of treatment is by the galvano-cautery, but excision has sometimes been employed where the nævus has been situated near the tip of the organ. **Papillomata,** in the shape of pedunculated warts, are not uncommon on the dorsum of the tongue. They should be removed, as they are liable to become ulcerated, and after a time epitheliomatous. **Lipomata** and **fibromata** are also found, but very rarely, on the tongue. The fibroma is perhaps the more common of the two.

Malignant tumours of the tongue.—The form of malignant disease which usually affects the tongue is squamous epithelioma, though some cases of sarcoma and lympho-sarcoma of the lymphoid tissue on the back part of the dorsum of the tongue have been recorded. The disease is much more common in men than in women, and usually occurs between the ages of 40 and 70. It almost invariably attacks the anterior two-thirds of the tongue, and usually commences on the margin. It may begin as a crack or fissure, as a warty growth or tubercle, or as a nodule or lump beneath the mucous membrane, and often originates in an abrasion caused by a jagged tooth, or else there is the history of some antecedent leucoplakia or ichthyosis. One of the main characteristics is the early formation of an ulcer with an indurated base. The ulcer is irregular, with raised,

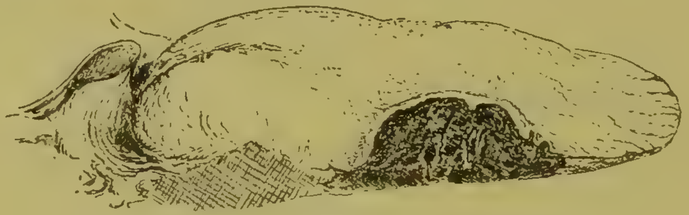

FIG. 252.—Epithelioma of tongue.
(From the Museum of St. George's Hospital.)

everted nodular margins, and a sloughy base, and is surrounded by a zone of induration, which gradually shades away into the normal tissues (fig. 252). The pain at first may be slight, but after a time becomes very severe, shooting up to the ear, and often radiating over the side of the head and face, and to all parts supplied with sensation by the fifth cranial nerve. The disease rapidly extends, and surrounding parts become involved; the floor of the mouth becomes infiltrated, so that the tongue becomes fixed: the patient is unable to protrude it, and deglutition and speech are interfered with. The voice becomes altered, swallowing is performed only with difficulty and pain, and the patient rapidly loses flesh from the inability to swallow, the pain, and the loss of appetite from the foul discharge which is constantly poisoning him. As the disease extends, the fauces, tonsils, and epiglottis may become involved, or the disease may spread from the floor of the mouth to the lower jaw, which may become implicated in the disease. The lymphatic glands beneath the jaw become early involved; at first they are simply enlarged and movable, but very soon they become fixed and break down, the skin over them gives way, and they fungate and frequently bleed, thus tending further to exhaust the patient. The progress is very rapid, and the duration of life, after the first appearance of the disease, if left untreated, is rarely more than two years.

The **diagnosis** of epithelioma of the tongue when the disease is well established is easy, and there is little or no difficulty in arriving at a correct opinion. It is only in the early stages, when there is commencing infiltration of a syphilitic ulcer or fissure, or a leucoplakial patch or a warty growth which is becoming epitheliomatous, that the diagnosis is difficult, but it is just in these cases that it is essential that a correct diagnosis should be formed, for it is in them that hope may be expressed that operative interference will hold out some prospect of giving lasting or permanent relief. Later on little can be done to cure the patient by operation, though it may do much to relieve him. In every case, therefore, where there is any doubt as to the nature of the disease, a small portion of the growth should be excised under cocaine, and examined microscopically.

A syphilitic gumma may be mistaken for that form of cancer which begins as a nodule beneath the mucous membrane, but the gumma commences in the muscular substance of the tongue, and involves the mucous membrane secondarily, whereas epithelioma takes it origin in the mucous membrane, and secondarily involves the deeper structures.

The main points in the diagnosis between tertiary ulceration and epithelioma of the tongue are as follows: In epithelioma the patient is almost always over forty, whereas in a considerable percentage of cases patients suffering from syphilitic ulcer are under forty. The ulcer in epithelioma is usually at the margin of the tongue; in syphilitic disease it is for the most part in the centre. The appearance of the sore in the two conditions is different; in the gummatous disease, the margins are sharp-cut, undermined and excavated, and it is covered with a wash-leather slough; in epithelioma the edges are raised, nodular and everted, and the surface of the sore foul. The induration in cancer is considerable and gradually fades away into normal tissues; in syphilis it is not nearly so great and is more limited and circumscribed. In cancer the tongue is more or less fixed, and speech and deglutition are difficult; but in syphilis the tongue is freely movable, and speech and swallowing are little affected. In epitheliomatous ulcer the pain is severe and radiates towards the ear; in gummatous ulcer there is usually little and in some cases no pain. The glands may be enlarged in either, but more frequently in cancerous disease, in which the lymphatic glands become involved within a few weeks of the appearance of ulceration. In addition to these differences, if there is more than one tumour the disease is almost certainly gummatous, and there may be other syphilitic lesions, so that their absence and the absence of any history of syphilis would point to epithelioma. Should any doubt still exist, the patient should be subjected to a course of antisyphilitic treatment, when the amelioration of the symptoms in the one case and their steady progress in the other would determine the nature of the disease.

Treatment.—The treatment of cancer of the tongue must be considered from a curative and palliative point of view. *Curative.* The only hope of curing a case of cancer of the tongue is by the thorough and free removal of the growth, and this should always be done in those cases in which the surgeon believes that it is possible to remove the whole of the growth, both primary and secondary glandular, if it exists; and the patient is not too exhausted by the cancer or some other intercurrent disease to withstand the shock of what must be necessarily a very severe operation. These two points are the indications which should influence the surgeon in coming to a conclusion as to whether a surgical operation, undertaken with the hope of curing the disease, should be performed or not. If he believes that he can remove the whole of the disease, without producing so much shock as will kill the patient, he is bound to give him the chance of the operation, since otherwise he condemns him to an inevitable death. In addition to this it must be borne in mind that the sufferings induced by a cancer of the tongue are of the most distressing and painful kind, and that the removal of the organ, even though it may not prolong life, may be the means of giving great relief to the patient, since death from secondary glandular disease entails far less suffering than the agonies produced by lingual epithelioma. *Palliative treatment.* In cases where the surgeon has to admit that the time for removal has passed, much may be done to assuage the patient's sufferings. When the pain is very great, resection of a portion of the lingual nerve (see page 391) affords temporary relief. The application of a solution of cocaine (2 per cent.) to the surface of the ulcer, especially before taking food, will often relieve the pain. The main dependence, however, is on the hypodermic injection of morphia, which will have to be given in gradually increasing doses in order to allay the pain and suffering. Antiseptic mouth washes must be constantly employed in order to remove the fœtor.

It has been proposed in these cases to tie the lingual artery, with a view of arresting the growth by cutting off the vascular supply to the part; experience has shown, however, that it is of little value.

Excision of the tongue.—Various operations have been suggested for removal of the tongue, and have been practised by different surgeons. These may be divided into two classes: intra-buccal operations and extra-buccal.

The **intra-buccal** operations are the ones which are most frequently employed, for they are the ones which are adapted to those cases where the disease is in an early stage, and limited to a portion of the tongue, and where therefore the operation is likely to give lasting or permanent relief. The operation may or may not be combined with a separate removal of the glands in the neck, but in most cases it is desirable to remove them, even though no enlargement can be detected. It has been seen that involvement of the glands takes place very early in cancer of the tongue; and though at the time of the operation it may be impossible to feel any enlargement, it will very often be found after division of the superficial structures and deep fascia in the submaxillary triangle that they are considerably involved.

The plan of removing the tongue by the intra-buccal method which is almost invariably adopted is that originally introduced by Mr. Whitehead, and consists in gradually snipping through the tongue with scissors and securing each vessel as it is divided. The old-fashioned plans of removing the tongue with the knife in one sweep, or with the écraseur, or with the galvano-cautery, have been practically abandoned. In operating for cancer of the tongue, the first point which has to be considered is whether the whole tongue should be removed or only a part, and on this point there is considerable difference of opinion. Some surgeons advocate the removal of the whole tongue in every case, others are content in cases where the disease is localised to remove only a small portion or one half. The removal of a small portion of the tongue is not, as a rule, to be recommended; but if any operation is undertaken, at least one half of the tongue should be removed, for by this means the lymphatic vessels, which accompany the lingual artery and vein, and three or four lymphatic glands, into which they empty and which lie on the superficial surface of the hyo-glossus muscles, are also removed. But there is something to be said in favour of removal of one half of the tongue. If the whole of one lateral half of the tongue is removed, when the growth implicates merely the margin of the organ, there is little tendency for the disease to return on the other side, and the after comfort of the patient is much greater, as speech and swallowing are not so much interfered with.

The operation, therefore, which I advocate in cases of cancer of the tongue, where the disease is seen and recognised in an early stage, and before the floor of the mouth has become implicated, is first of all to make a preliminary incision in the submaxillary region, and remove the lymphatic glands from this region, as well as the submaxillary gland, and tie the lingual artery, which much facilitates the subsequent removal of the tongue. After this has been done, the half of the tongue is removed by the intra-buccal method, by first splitting it down the centre, and then snipping through its base, close to the hyoid bone, with scissors.

The steps of the operation are as follows: the patient being in the supine position, and the head turned to the opposite side to that on which the disease is situated, a curved incision is made from near the symphysis of the jaw to the level of the hyoid bone and back to the edge of the sterno-mastoid, and the submaxillary triangle exposed. The whole of the cellular tissue and glands from the space are to be removed, and it is also advisable to remove the submaxillary gland, so as to diminish the secretion of the saliva. In doing this the facial vessels will probably be divided and will require ligature. When the space has been cleared the lingual artery is to be sought for in the triangle between the hypoglossal nerve, the free border of the mylo-hyoid muscle, and the curved tendon of the digastric, beneath the fibres of the hyo-glossus muscle. The muscular fibres over the artery must be divided, and a ligature passed round the vessel (see page 342). The external wound may now be closed and loosely covered with gauze, while the surgeon proceeds to extirpate the half of the tongue. The mouth is well opened with a Mason's gag, and a stout silk ligature passed through each half of the tongue near its tip, by which it can be held, and the tongue is pulled out of the mouth. The mucous membrane of the dorsum of the tongue is then to be divided in the middle line throughout its whole length, the incision being carried over the tip, dividing the mucous membrane of the floor of the mouth as far as the bone. By now seizing the ligatures which have transfixed the tongue and pulling them apart, the halves of the tongue may be torn from each other along the median raphé, the separation being aided by the forefingers tearing the muscular fibres apart. When this separation has been made as far backwards as possible, the surgeon holds the ligature which transfixes the half of the tongue which has to be removed in his left hand, and by pulling on it tenses the reflection of the mucous membrane from the tongue to the lower jaw, and divides it with curved scissors close to the bone. He divides also the attachment of the genio-hyo-glossus to the upper genial tubercle, and snips through the anterior pillar of the fauces. It will now be found that the whole of this half of the tongue can be pulled out of the mouth. He now proceeds leisurely to snip through the muscular substance of the tongue, commencing on the dorsum close to the glosso-epiglottidean folds, and in doing this as he gets to the under surface he will divide the extrinsic muscles attached to the under surface of the tongue, the stylo-glossus, the hyo-glossus and the genio-hyo-glossus. In dividing the fibres of the hyo-glossus he must be careful to remove also the glands which lie on its superficial surface. Should the lingual or any artery bleed, it must at once be seized by an assistant with clip forceps ; and should the bleeding be severe, which can only occur in those cases where the lingual artery has not been secured beforehand, the plan recommended by Christopher Heath should be adopted. The forefinger is passed over the tongue till it touches the epiglottis, and is then turned towards the side on which the artery is to be compressed and pushed forcibly against the jaw.

After the half of the tongue has been removed, any bleeding points, if there are any, should be secured with ligatures.

The whole tongue may be removed by a somewhat similar proceeding. A strong ligature is passed through the tip. The frænum, mucous membrane of the floor of the mouth, genio-hyo-glossus muscle and anterior pillar of the fauces are divided with scissors, and the tongue pulled well out of the mouth. It is then gradually snipped through with scissors, the lingual arteries being secured with clip forceps just before they are divided.

The whole of the rawed surface is now to be painted over with Whitehead's varnish, consisting of friar's balsam, in which a saturated solution of iodoform in ether is substituted for the alcohol ; or it may be freely dusted with iodoform.

The **extra-buccal** modes of removing the tongue are numerous, but it will be sufficient if we describe in this place the two methods which are most frequently adopted.

1. **Kocher's operation** is employed in those cases where the floor of the mouth and the glands in the submaxillary triangle are secondarily implicated. A preliminary tracheotomy is first performed, and the pharynx plugged with a sponge or gauze. The anæsthetic is given through the tracheotomy tube. An incision is now made from the apex of the mastoid process, down the anterior border of the sterno-mastoid muscle as far as the level of the greater cornu of the hyoid bone ; it is then carried inwards along the hyoid bone to the middle line of the neck and upwards to the symphysis menti. The somewhat quadrangular flap is dissected upwards as far as the level of the jaw, and the submaxillary space thoroughly cleared of all lymphatic glands, submaxillary and sublingual salivary glands and cellular tissue, and the facial and lingual arteries are tied. If the whole tongue is to be removed, the lingual artery is tied on the opposite side through a separate incision (see page 342). The mylo-hyoid muscle is separated from its attachment to the mylo-hyoid ridge of the lower jaw, and the mucous membrane of the floor of the mouth divided. The tongue is then drawn through the hole that has been made, and removed by scissors or galvano-cautery. The whole of the gap which has been left, and the mouth, are plugged with gauze, which is changed twice a day, and the external wound is not sutured, but is allowed to heal by granulation.

2. **Syme's operation** is also applicable to cases where the disease implicates the floor of the mouth, and to those where the disease in-

volves the lower jaw, as by it portions of the bone may be removed. Having performed both Syme's and Kocher's operations, I give preference to the former. It is not to my mind so serious an operation, and does not require so long a time in its performance. It does not necessitate a preliminary tracheotomy, and the period of convalescence is much shorter. By it the whole of the floor of the mouth and the contents of the submaxillary space can be as thoroughly removed as by Kocher's operation. In the three or four cases in which I have performed this operation, I have experienced no difficulty in getting the divided bone to unite, though tardy union or non-union is said to be one of the disadvantages attending this mode of proceeding. The operation is performed by making an incision from the middle of the lower lip through the soft parts of the chin as far as the hyoid bone. The bone is then drilled on either side of the symphysis, and divided between the drill-holes with a saw. The halves of the jaw are forcibly retracted, and the mucous membrane divided close to the bone, the tongue being held, by a ligature passed through it, so as to prevent its falling backwards. The muscles attached to the inner surface of the jaw are now divided on either side, and the whole of the tissues in the submaxillary triangle removed, each vessel as it is wounded being seized with clip forceps. The tongue thus freed is cut away posteriorly from its attachment with scissors. If any portion of the bone is involved, it is isolated by saw cuts in front and behind, and removed; leaving, if possible, a bridge of bone to maintain the continuity of the jaw.

In cases where the whole thickness of the jaw has not been removed, the two halves may be now wired, and the external wound sutured, a drainage tube being passed through from the mouth at the lower point of the wound.

After the operation for removal of the tongue, the mouth should be washed out constantly with Condy's fluid (ʒi to Oj) or other antiseptic wash, and painted daily with Whitehead's varnish; rectal feeding may be necessary for a day or two, but in many cases the patient is able to take fluid food by the mouth from the first, and is often able to leave his bed on the third or fourth day.

DISEASES OF THE TONSILS

Acute tonsillitis.—The tonsils are liable to acute inflammation from various causes, such as exposure to cold; the inhalation of impure air, especially when contaminated with sewer gas. It is particularly liable to occur in persons who are the subjects of the rheumatic diathesis, or it may occur in the course of one of the exanthematous fevers, especially scarlet fever. It presents itself in three different forms:

(1) **Acute superficial tonsillitis,** generally arising from exposure to cold, and consisting in a superficial redness of the whole of the fauces, soft palate and pharynx. There is a little swelling, smarting pain, and difficulty in swallowing. There is a slight rise in the temperature, but no great amount of constitutional disturbance. All the treatment which is necessary is confinement to the house for a couple of days, a brisk purge and some chlorate of potash gargle or lozenges.

(2) **Acute follicular tonsillitis.**—This is a more common condition, and is especially liable to occur from the inhalation of

impure air, and is very frequent among residents in hospitals, not only patients, but also house surgeons, nurses, &c., and therefore is commonly known as *hospital throat.* It is characterised by enlargement of one or both tonsils, which become dusky red in colour, and a secretion is seen oozing from the mouths of the inflamed follicles; this may coagulate on the surface, forming a yellow patchy exudation, which might be mistaken for diphtheria, but unlike the false membrane of this disease is not adherent, and can be readily brushed away with a camel-hair brush. The disease is ushered in by a sudden rise of temperature, and sometimes a rigor. There is pain in the throat darting up to the ear, and obstruction to both breathing and swallowing. The tongue becomes furred, the breath offensive, the saliva runs copiously from the mouth, and the glands behind the angle of the jaw become enlarged. The disease usually subsides under treatment in the course of two or three days.

Treatment should be commenced with a brisk calomel purge, followed by twenty-grain doses of salicylate of soda every four hours for three or four doses, which often has the effect of at once cutting short the disease. Locally the throat should be frequently gargled with chlorate of potash gargle. Later on quinine or tincture of perchloride of iron should be given in full doses. The diet must be fluid, and a small quantity of port wine daily is beneficial.

(3) **Acute parenchymatous tonsillitis—cynanche tonsillaris** or **quinsy**—is a more diffuse inflammation, affecting not only the tonsil, but also the neighbouring soft palate and fauces. It begins with a chill or perhaps rigor, with stiffness and pain at the back of the throat, especially in swallowing. One side of the soft palate and the corresponding tonsil is swollen and red. There is difficulty in breathing, which is sometimes so great that the patient may dread suffocation. Gradually the tonsil softens, an abscess forms in its substance, and when this is opened or bursts, the patient immediately experiences great relief. In some cases, after the inflammation has subsided in one tonsil, the other becomes similarly affected.

The **treatment** must commence with a sharp purge, and the throat should be steamed by inhaling over boiling water, to which a little creasote or eucalyptus may be added. Great relief is often afforded by making scarifications into the inflamed tissues, even though no pus is found. Care must be taken not to direct the knife outwards in making these incisions, on account of the proximity of the internal carotid artery. After matter has formed, one of these incisions will open the abscess and at once relieve the patient. Hot fomentations should be applied outside to the throat, and the patient have as much fluid nourishment as he can take.

Chronic tonsillitis is generally the sequel of the acute disease, after which the organs remain enlarged, and occasionally become swollen, congested, and painful under the influence of slight causes.

Chronic enlargement of the tonsils is an extremely common affection in tuberculous children, in whom it is frequently associated with adenoid growths in the naso-pharynx. It consists in a true hypertrophy of the normal structures of the organ, especially the lymphoid tissue. The tonsils, on examination, are seen to be enlarged, sometimes so much so as to meet in the middle line; they are pale in colour and firm in consistence: the crypts on their surface are enlarged, and are filled with a mucous secretion, which sometimes becomes caseous, and may be seen protruding from the crypts in the form of whitish plugs. These sometimes become infiltrated with lime salts, forming concretions. When much enlarged there is obstruction to the breathing; the child breathes with the mouth open, snores in its sleep, and speaks thickly. When the enlargement is moderate in amount, the principal inconvenience arises from repeated attacks of inflammation to which the child is liable, and which leave the tonsil larger after each attack. But when the tonsils have become considerably enlarged, they become the source of serious derangement to the general health. They spoil the voice, which becomes thick and husky; they impede the hearing; they prevent sleep except with the mouth open, and the child is apt to suddenly waken with a feeling of suffocation; and they obstruct respiration, so as to produce a partial vacuum in the chest, which leads to permanent deformity, imperfect aeration of the blood, and an interference with the general nutrition of the child.

Treatment.—In cases of slight enlargement of the tonsil it is advisable to try the effect of constitutional treatment before resorting to operation, especially if the child is very young; but if the enlargement is considerable there is only one effectual mode of treatment, by removing a part of the gland. The constitutional treatment consists in the internal administration of iron and cod-liver oil and strict attention to hygienic surroundings, with the local application of iodine or perchloride of iron and glycerine to the tonsil.

Tonsillectomy may be performed either by means of the bistoury or by a special instrument called a guillotine. Personally, I prefer to remove a part of the tonsil with the bistoury, as by this means the lower part of the organ, which often hangs down into the pharynx, can with certainty be removed, but very often escapes removal when the guillotine is used. To excise the tonsils with the bistoury in children, it is, however, necessary to administer an anæsthetic, whereas this is not always required in removing them with the guillotine if the fauces have been brushed over with a 10 per cent. solution of cocaine. In performing the operation with the bistoury the child is anæsthetised, and the mouth having been opened by means of a gag, the head is raised and allowed to rest against the shoulder of the anæsthetist, so that a good view can be obtained. The left tonsil is now seized with a volsellum, and the projecting mass cut off from above downwards, inclining the cutting edge of the knife slightly inwards as it cuts its way through, so as to avoid all risk of wounding the internal carotid artery. The instruments are now changed in the hands, the knife being held in the left and the volsellum in the right, and the other tonsil similarly removed. It is advisable to guard the cutting edge of the posterior part of the blade of the bistoury by winding a piece of lint around it, so as to avoid injuring the tongue or lips. In removing the tonsils with a guillotine, the patient, if old enough to submit to the operation without an anæsthetic, may be seated in a chair in a good light, and the tongue being held out of the way with a depressor, the ring of the instrument is passed over the projecting tonsil, which may be pressed into it by the finger pushing the parts inwards behind the angle of the jaw. By the pressure of the thumb on the cutting blade the projecting portion of the gland is at once removed.

The bleeding after removal of the tonsil is generally very slight, unless in attempting to remove too much the vessels of the soft palate are injured, or, what must be a very uncommon accident, the internal carotid artery is wounded. It should be borne in mind that all that is necessary is to cut off the projecting mass, and not to remove the whole tonsil. In performing solution of bicarbonate of potash (gr. xx to ℥j), and the teeth brushed. Dilute chromic acid and concentrated lactic acid have been recommended as local applications, but sometimes appear to aggravate the disease. Internally the administration of arsenic appears to do good, and in syphilitic cases antisyphilitic remedies must be exhibited. In these latter cases I have found the internal administration of Donovan's solution - liquor arsenii et hydrarg. iodidi—with a powder consisting of grey powder five grains, and compound tragacanth powder fifteen grains, to be placed on the tongue once a day, the best means of treating these cases. The powder forms a paste with the saliva, and gradually dissolves. While doing so it is to be kept in contact with the diseased surface.

Annulus migrans.—Another condition of the tongue has been described, occurring principally in children, but also sometimes in adults. It commences as small round spots of light-coloured appearance, which rapidly develop into a more or less complete circle, and spread centrifugally over the tongue. It is not very painful, but causes a sensation of itching, and is attended with increased salivation. It bears some resemblance to ringworm, but is not apparently due to a parasite. The disease is very chronic in character, may disappear for a time, and then reappear. No treatment appears to have any effect on it.

Ulceration of the tongue.—The varieties of ulcer to which the tongue is liable are the irritable, the dyspeptic, the tuberculous, and the syphilitic. (1) *Irritable ulcers* are usually caused by the irritation produced by a jagged tooth. They are therefore situated on the side of the tongue, and are often very painful. The treatment consists in extracting or filing the tooth. (2) *Dyspeptic ulcers* are usually multiple, and situated on the dorsum and sides of the tongue. The ulcers are circular and superficial with an inflamed area around. They are not indurated; are very painful, especially during mastication. The treatment consists in correcting the state of the digestive organs, and touching the ulcers with nitrate of silver. (3) *Tuberculous ulcer* is a rare disease which has only been recognised of recent years. It is generally secondary to tuberculous disease of the lungs or larynx, the organ being infected by the sputum. It consists in an isolated mass of tubercle, which caseates and breaks down, forming an irregular ulcer, generally on the under surface or sides of the tip of the tongue. The edges are sharply defined, the base nodular and uneven, and it is exquisitely painful, often causing intolerable suffering. **Treatment** must be directed to relieving the pain, since the disease is incurable on account of the constitutional condition. If this is very severe, the ulcer should be freely scraped, which will do much to relieve the pain. It has been advised in some of these cases to resect a portion of the lingual nerve. In less painful cases the local application of iodoform and morphia, and the administration of cod-liver oil, are indicated. (4) *Syphilitic ulcer* of the tongue is one of many forms of syphilitic affections of this organ, which it is more convenient to consider together.

Syphilitic affections of the tongue may occur in primary, secondary, and tertiary syphilis. In the *primary disease* a syphilitic sore or chancre is occasionally found on the tongue, though not so commonly as on the lips. It is much more common in the male than the female, and the infection would appear to be due, in most cases, to smoking the pipe of a person affected with syphilis. The sore presents the ordinary characteristics of a chancre, it soon becomes indurated, and is associated with enlargement of the submaxillary glands. It speedily heals under the influence of mercury. In *secondary syphilis*, mucous plaques, such as are found in syphilitic stomatitis (page 186), occur on the tongue, and also sometimes superficial ulcerations; they are usually multiple, roundish, with greyish bases, and sharp-cut edges. They are very painful, and are generally associated with similar sores on the lips, palate, and tonsils. Occasionally wart-like condylomata are found on the tongue in secondary syphilis. *Tertiary syphilis* shows itself in two ways in the tongue. One of these is where the tongue becomes enlarged by the diffusion through it of numerous small gummata; the other is much the more common, where the infiltration is localised, and gives rise to a definite gumma, which breaks down and forms a tertiary syphilitic ulcer. The disease usually commences in the muscular substance of the tongue near its centre, though occasionally superficial gummata form in the submucous tissue. The swelling is at first hard and firm, and usually appears about the centre of the dorsum of the tongue, a little to one side of the middle line. The swelling increases steadily if left untreated, and gradually softens. The mucous membrane, which up to this time has remained normal in appearance, now becomes involved and gives way, leaving an ulcer, which is usually oval or elongated, with sharp-cut undermined edges, and containing an adherent slough of the characteristic wet wash-leather appearance (fig. 40). There is usually little induration around at first, but in a tertiary ulcer which has been allowed to remain untreated a certain amount of induration may be found. In these cases, which are the ones most liable to be mistaken for malignant disease, the structures in the floor of the mouth are not implicated, so that the tongue can be protruded freely, and there is little or no interference with deglutition or articulation.

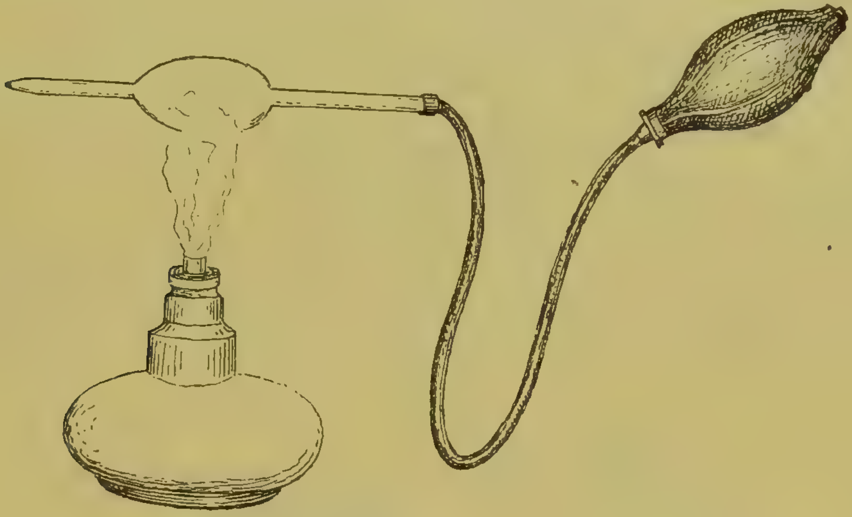

FIG. 251.—Apparatus for local calomel fumigation.

Under treatment a gumma of large size may be absorbed without softening and breaking down; and if this has occurred before treatment is commenced, the ulcer heals readily under antisyphilitic treatment, leaving a deep linear cicatrix.

Treatment.—Most cases of tertiary syphilitic ulceration of the tongue yield to the influence of iodide of potassium, if given in full doses. The healing is, however, very often hastened by the local fumigation of calomel.

This can be easily applied by means of a glass tube, with a bulb, in which the calomel is placed. To one end of the tube an india-rubber ball is attached, and the calomel having been sublimed by a spirit lamp placed under the bulb, the ulcer can be readily sprayed with the vapour (fig. 251).

Tumours of the tongue.—Innocent tumours of the tongue are occasionally met with, but the most common form of tumour is epithelioma. Among innocent growths, probably **nævus** is the most common. They are usually of the cavernous variety, and are often situated deeply in the substance of the organ. They rarely cause much inconvenience unless they attain a large size. The best mode of treatment is by the galvano-cautery, but excision has sometimes been employed where the nævus has been situated near the tip of the organ. **Papillomata,** in the shape of pedunculated warts, are not uncommon on the dorsum of the tongue. They should be removed, as they are liable to become ulcerated, and after a time epitheliomatous. **Lipomata** and **fibromata** are also found, but very rarely, on the tongue. The fibroma is perhaps the more common of the two.

Malignant tumours of the tongue.—The form of malignant disease which usually affects the tongue is squamous epithelioma, though some cases of sarcoma and lympho-sarcoma of the lymphoid tissue on the back part of the dorsum of the tongue have been recorded. The disease is much more common in men than in women, and usually occurs between the ages of 40 and 70. It almost invariably attacks the anterior two-thirds of the tongue, and usually commences on the margin. It may begin as a crack or fissure, as a warty growth or tubercle, or as a nodule or lump beneath the mucous membrane, and often originates in an abrasion caused by a jagged tooth, or else there is the history of some antecedent leucoplakia or ichthyosis. One of the main characteristics is the early formation of an ulcer with an indurated base. The ulcer is irregular, with raised, everted nodular margins, and a sloughy base, and is surrounded by a zone of induration, which gradually shades away into the normal tissues (fig. 252). The pain at first may be slight, but after a time becomes very severe, shooting up to the ear, and often radiating over the side of the head and face, and to all parts supplied with sensation by the fifth cranial nerve. The disease rapidly extends, and surrounding parts become involved; the floor of the mouth becomes infiltrated, so that the tongue becomes fixed; the patient is unable to protrude it, and deglutition and speech are interfered with. The voice becomes altered, swallowing is performed only with difficulty and pain, and the patient rapidly loses flesh from the inability to swallow, the pain, and the loss of appetite from the foul discharge which is constantly poisoning him. As the disease extends, the fauces, tonsils, and epiglottis may become involved, or the disease may spread from the floor of

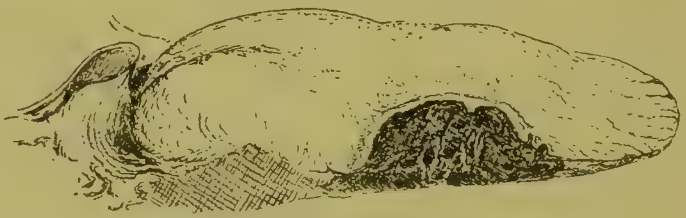

FIG. 252.—Epithelioma of tongue.
(From the Museum of St. George's Hospital.)

the mouth to the lower jaw, which may become implicated in the disease. The lymphatic glands beneath the jaw become early involved; at first they are simply enlarged and movable, but very soon they become fixed and break down, the skin over them gives way, and they fungate and frequently bleed, thus tending further to exhaust the patient. The progress is very rapid, and the duration of life, after the first appearance of the disease, if left untreated, is rarely more than two years.

The **diagnosis** of epithelioma of the tongue when the disease is well established is easy, and there is little or no difficulty in arriving at a correct opinion. It is only in the early stages, when there is commencing infiltration of a syphilitic ulcer or fissure, or a leucoplakial patch or a warty growth which is becoming epitheliomatous, that the diagnosis is difficult, but it is just in these cases that it is essential that a correct diagnosis should be formed, for it is in them that hope may be expressed that operative interference will hold out some prospect of giving lasting or permanent relief. Later on little can be done to cure the patient by operation, though it may do much to relieve him. In every case, therefore, where there is any doubt as to the nature of the disease, a small portion of the growth should be excised under cocaine, and examined microscopically.

A syphilitic gumma may be mistaken for that form of cancer which begins as a nodule beneath the mucous membrane, but the gumma commences in the muscular substance of the tongue, and involves the mucous membrane secondarily, whereas epithelioma takes it origin in the mucous membrane, and secondarily involves the deeper structures.

The main points in the diagnosis between tertiary ulceration and epithelioma of the tongue are as follows: In epithelioma the patient is almost always over forty, whereas in a considerable percentage of cases patients suffering from syphilitic ulcer are under forty. The ulcer in epithelioma is usually at the margin of the tongue; in syphilitic disease it is for the most part in the centre. The appearance of the sore in the two conditions is different; in the gummatous disease, the margins are sharp-cut, undermined and excavated, and it is covered with a wash-leather slough; in epithelioma the edges are raised, nodular and everted, and the surface of the sore foul. The induration in cancer is considerable and gradually fades away into normal tissues; in syphilis it is not nearly so great and is more limited and circumscribed. In cancer the tongue is more or less fixed, and speech and deglutition are difficult; but in syphilis the tongue is freely movable, and speech and swallowing are little affected. In epitheliomatous ulcer the pain is severe and radiates towards the ear; in gummatous ulcer there is usually little and in some cases no pain. The glands may be enlarged in either, but more frequently in cancerous disease, in which the lymphatic glands become involved within a few weeks of the appearance of ulceration. In addition to these differences, if there is more than one tumour the disease is almost certainly gummatous, and there may be other syphilitic lesions, so that their absence and the absence of any history of syphilis would point to epithelioma. Should any doubt still exist, the patient should be subjected to a course of antisyphilitic treatment, when the amelioration of the symptoms in the one case and their steady progress in the other would determine the nature of the disease.

Treatment.—The treatment of cancer of the tongue must be considered from a curative and palliative point of view. *Curative.* The only hope of curing a case of cancer of the tongue is by the thorough and free removal of the growth, and this should always be done in those cases in which the surgeon believes that it is possible to remove the whole of the growth, both primary and secondary glandular, if it exists; and the patient is not too exhausted by the cancer or some other intercurrent disease to withstand the shock of what must be necessarily a very severe operation. These two points are the indications which should influence the surgeon in coming to a conclusion as to whether a surgical operation, undertaken with the hope of curing the disease, should be performed or not. If he believes that he can remove the whole of the disease, without producing so much shock as will kill the patient, he is bound to give him the chance of the operation, since otherwise he condemns him to an inevitable death. In addition to this it must be borne in mind that the sufferings induced by a cancer of the tongue are of the most distressing and painful kind, and that the removal of the organ, even though it may not prolong life, may be the means of giving great relief to the patient, since death from secondary glandular disease entails far less suffering than the agonies produced by lingual epithelioma. *Palliative treatment.* In cases where the surgeon has to admit that the time for removal has passed, much may be done to assuage the patient's sufferings. When the pain is very great, resection of a portion of the lingual nerve (see page 391) affords temporary relief. The application of a solution of cocaine (2 per cent.) to the surface of the ulcer, especially before taking food, will often relieve the pain. The main dependence, however, is on the hypodermic injection of morphia, which will have to be given in gradually increasing doses in order to allay the pain and suffering. Antiseptic mouth washes must be constantly employed in order to remove the fœtor.

It has been proposed in these cases to tie the lingual artery, with a view of arresting the growth by cutting off the vascular supply to the part; experience has shown, however, that it is of little value.

Excision of the tongue.—Various operations have been suggested for removal of the tongue, and have been practised by different surgeons. These may be divided into two classes: intra-buccal operations and extra-buccal.

The **intra-buccal** operations are the ones which are most frequently employed, for they are the ones which are adapted to those cases where the disease is in an early stage, and limited to a portion of the tongue, and where therefore the operation is likely to give lasting or permanent relief. The operation may or may not be combined with a separate removal of the glands in the neck, but in most cases it is desirable to remove them, even though no enlargement can be detected. It has been seen that involvement of the glands takes place very early in cancer of the tongue; and though at the time of the operation it may be impossible to feel any enlargement, it will very often be found after division of the superficial structures and deep fascia in the submaxillary triangle that they are considerably involved.

The plan of removing the tongue by the intra-buccal method which is almost invariably adopted is that originally introduced by Mr. Whitehead, and consists in gradually snipping through the tongue with scissors and securing each vessel as it is divided. The old-fashioned plans of removing the tongue with the knife in one sweep, or with the écraseur, or with the galvano-cautery, have been practically abandoned. In operating for cancer of the tongue, the first point which has to be considered is whether the whole tongue should be removed or only a part, and on this point there is considerable difference of opinion. Some surgeons advocate the removal of the whole tongue in every case, others are content in cases where the disease is localised to remove only a small portion or one half. The removal of a small portion of the tongue is not, as a rule, to be recommended; but if any operation is undertaken, at least one half of the tongue should be removed, for by this means the lymphatic vessels, which accompany the lingual artery and vein, and three or four lymphatic glands, into which they empty and which lie on the superficial surface of the hyo-glossus muscles, are also removed. But there is something to be said in favour of removal of one half of the tongue. If the whole of one lateral half of the tongue is removed, when the growth implicates merely the margin of the organ, there is little tendency for the disease to return on the other side, and the after comfort of the patient is much greater, as speech and swallowing are not so much interfered with.

The operation, therefore, which I advocate in cases of cancer of the tongue, where the disease is seen and recognised in an early stage, and before the floor of the mouth has become implicated, is first of all to make a preliminary incision in the submaxillary region, and remove the lymphatic glands from this region, as well as the submaxillary gland, and tie the lingual artery, which much facilitates the subsequent removal of the tongue. After this has been done, the half of the tongue is removed by the intra-buccal method, by first splitting it down the centre, and then snipping through its base, close to the hyoid bone, with scissors.

The steps of the operation are as follows: the patient being in the supine position, and the head turned to the opposite side to that on which the disease is situated, a curved incision is made from near the symphysis of the jaw to the level of the hyoid bone and back to the edge of the sterno-mastoid, and the submaxillary triangle exposed. The whole of the cellular tissue and glands from the space are to be removed, and it is also advisable to remove the submaxillary gland, so as to diminish the secretion of the saliva. In doing this the facial vessels will probably be divided and will require ligature. When the space has been cleared the lingual artery is to be sought for in the triangle between the hypoglossal nerve, the free border of the mylo-hyoid muscle, and the curved tendon of the digastric, beneath the fibres of the hyo-glossus muscle. The muscular fibres over the artery must be divided, and a ligature passed round the vessel (see page 342). The external wound may now be closed and loosely covered with gauze, while the surgeon proceeds to extirpate the half of the tongue. The mouth is well opened with a Mason's gag, and a stout silk ligature passed through each half of the tongue near its tip, by which it can be held, and the tongue is pulled out of the mouth. The mucous membrane of the dorsum of the tongue is then to be divided in the middle line throughout its whole length, the incision being carried over the tip, dividing the mucous membrane of the floor of the mouth as far as the bone. By now seizing the ligatures which have transfixed the tongue and pulling them apart, the halves of the tongue may be torn from each other along the median raphé, the separation being aided by the forefingers tearing the muscular fibres apart. When this separation has been made as far backwards as possible, the surgeon holds the ligature which transfixes the half of the tongue which has to be removed in his left hand, and by pulling on it tenses the reflection of the mucous membrane from the tongue to the lower jaw, and divides it with curved scissors close to the bone. He divides also the attachment of the genio-hyo-glossus to the upper genial tubercle, and snips through the anterior pillar of the fauces. It will now be found that the whole of this half of the tongue can be pulled out of the mouth. He now proceeds leisurely to snip through the muscular substance of the tongue, commencing on the dorsum close to the glosso-epiglottidean folds, and in doing this as he gets to the under surface he will divide the extrinsic muscles attached to the under surface of the tongue, the stylo-glossus, the hyo-glossus and the genio-hyo-glossus. In dividing the fibres of the hyo-glossus he must be careful to remove also the glands which lie on its superficial surface. Should the lingual or any artery bleed, it must at once be seized by an assistant with clip forceps; and should the bleeding be severe, which can only occur in those cases where the lingual artery has not been secured beforehand, the plan recommended by Christopher Heath should be adopted. The forefinger is passed over the tongue till it touches the epiglottis, and is then turned towards the side on which the artery is to be compressed and pushed forcibly against the jaw.

After the half of the tongue has been removed, any bleeding points, if there are any, should be secured with ligatures.

The whole tongue may be removed by a somewhat similar proceeding. A strong ligature is passed through the tip. The frænum, mucous membrane of the floor of the mouth, genio-hyo-glossus muscle and anterior pillar of the fauces are divided with scissors, and the tongue pulled well out of the mouth. It is then gradually snipped through with scissors, the lingual arteries being secured with clip forceps just before they are divided.

The whole of the rawed surface is now to be painted over with Whitehead's varnish, consisting of friar's balsam, in which a saturated solution of iodoform in ether is substituted for the alcohol; or it may be freely dusted with iodoform.

The **extra-buccal** modes of removing the tongue are numerous, but it will be sufficient if we describe in this place the two methods which are most frequently adopted.

1. **Kocher's operation** is employed in those cases where the floor of the mouth and the glands in the submaxillary triangle are secondarily implicated. A preliminary tracheotomy is first performed, and the pharynx plugged with a sponge or gauze. The anæsthetic is given through the tracheotomy tube. An incision is now made from the apex of the mastoid process, down the anterior border of the sterno-mastoid muscle as far as the level of the greater cornu of the hyoid bone; it is then carried inwards along the hyoid bone to the middle line of the neck and upwards to the symphysis menti. The somewhat quadrangular flap is dissected upwards as far as the level of the jaw, and the submaxillary space thoroughly cleared of all lymphatic glands, submaxillary and sublingual salivary glands and cellular tissue, and the facial and lingual arteries are tied. If the whole tongue is to be removed, the lingual artery is tied on the opposite side through a separate incision (see page 342). The mylo-hyoid muscle is separated from its attachment to the mylo-hyoid ridge of the lower jaw, and the mucous membrane of the floor of the mouth divided. The tongue is then drawn through the hole that has been made, and removed by scissors or galvano-cautery. The whole of the gap which has been left, and the mouth, are plugged with gauze, which is changed twice a day, and the external wound is not sutured, but is allowed to heal by granulation.

2. **Syme's operation** is also applicable to cases where the disease implicates the floor of the mouth, and to those where the disease in-

volves the lower jaw, as by it portions of the bone may be removed. Having performed both Syme's and Kocher's operations, I give preference to the former. It is not to my mind so serious an operation, and does not require so long a time in its performance. It does not necessitate a preliminary tracheotomy, and the period of convalescence is much shorter. By it the whole of the floor of the mouth and the contents of the submaxillary space can be as thoroughly removed as by Kocher's operation. In the three or four cases in which I have performed this operation, I have experienced no difficulty in getting the divided bone to unite, though tardy union or non-union is said to be one of the disadvantages attending this mode of proceeding. The operation is performed by making an incision from the middle of the lower lip through the soft parts of the chin as far as the hyoid bone. The bone is then drilled on either side of the symphysis, and divided between the drill-holes with a saw. The halves of the jaw are forcibly retracted, and the mucous membrane divided close to the bone, the tongue being held, by a ligature passed through it, so as to prevent its falling backwards. The muscles attached to the inner surface of the jaw are now divided on either side, and the whole of the tissues in the submaxillary triangle removed, each vessel as it is wounded being seized with clip forceps. The tongue thus freed is cut away posteriorly from its attachment with scissors. If any portion of the bone is involved, it is isolated by saw cuts in front and behind, and removed; leaving, if possible, a bridge of bone to maintain the continuity of the jaw.

In cases where the whole thickness of the jaw has not been removed, the two halves may be now wired, and the external wound sutured, a drainage tube being passed through from the mouth at the lower point of the wound.

After the operation for removal of the tongue, the mouth should be washed out constantly with Condy's fluid (ʒi to Oj) or other antiseptic wash, and painted daily with Whitehead's varnish; rectal feeding may be necessary for a day or two, but in many cases the patient is able to take fluid food by the mouth from the first, and is often able to leave his bed on the third or fourth day.

DISEASES OF THE TONSILS

Acute tonsillitis.—The tonsils are liable to acute inflammation from various causes, such as exposure to cold; the inhalation of impure air, especially when contaminated with sewer gas. It is particularly liable to occur in persons who are the subjects of the rheumatic diathesis, or it may occur in the course of one of the exanthematous fevers, especially scarlet fever. It presents itself in three different forms:

(1) **Acute superficial tonsillitis,** generally arising from exposure to cold, and consisting in a superficial redness of the whole of the fauces, soft palate and pharynx. There is a little swelling, smarting pain, and difficulty in swallowing. There is a slight rise in the temperature, but no great amount of constitutional disturbance. All the treatment which is necessary is confinement to the house for a couple of days, a brisk purge and some chlorate of potash gargle or lozenges.

(2) **Acute follicular tonsillitis.**—This is a more common condition, and is especially liable to occur from the inhalation of

impure air, and is very frequent among residents in hospitals, not only patients, but also house surgeons, nurses, &c., and therefore is commonly known as *hospital throat.* It is characterised by enlargement of one or both tonsils, which become dusky red in colour, and a secretion is seen oozing from the mouths of the inflamed follicles; this may coagulate on the surface, forming a yellow patchy exudation, which might be mistaken for diphtheria, but unlike the false membrane of this disease is not adherent, and can be readily brushed away with a camel-hair brush. The disease is ushered in by a sudden rise of temperature, and sometimes a rigor. There is pain in the throat darting up to the ear, and obstruction to both breathing and swallowing. The tongue becomes furred, the breath offensive, the saliva runs copiously from the mouth, and the glands behind the angle of the jaw become enlarged. The disease usually subsides under treatment in the course of two or three days.

Treatment should be commenced with a brisk calomel purge, followed by twenty-grain doses of salicylate of soda every four hours for three or four doses, which often has the effect of at once cutting short the disease. Locally the throat should be frequently gargled with chlorate of potash gargle. Later on quinine or tincture of perchloride of iron should be given in full doses. The diet must be fluid, and a small quantity of port wine daily is beneficial.

(3) **Acute parenchymatous tonsillitis—cynanche tonsillaris** or **quinsy**—is a more diffuse inflammation, affecting not only the tonsil, but also the neighbouring soft palate and fauces. It begins with a chill or perhaps rigor, with stiffness and pain at the back of the throat, especially in swallowing. One side of the soft palate and the corresponding tonsil is swollen and red. There is difficulty in breathing, which is sometimes so great that the patient may dread suffocation. Gradually the tonsil softens, an abscess forms in its substance, and when this is opened or bursts, the patient immediately experiences great relief. In some cases, after the inflammation has subsided in one tonsil, the other becomes similarly affected.

The **treatment** must commence with a sharp purge, and the throat should be steamed by inhaling over boiling water, to which a little creasote or eucalyptus may be added. Great relief is often afforded by making scarifications into the inflamed tissues, even though no pus is found. Care must be taken not to direct the knife outwards in making these incisions, on account of the proximity of the internal carotid artery. After matter has formed, one of these incisions will open the abscess and at once relieve the patient. Hot fomentations should be applied outside to the throat, and the patient have as much fluid nourishment as he can take.

Chronic tonsillitis is generally the sequel of the acute disease, after which the organs remain enlarged, and occasionally become swollen, congested, and painful under the influence of slight causes.

Chronic enlargement of the tonsils is an extremely common affection in tuberculous children, in whom it is frequently associated with adenoid growths in the naso-pharynx. It consists in a true hypertrophy of the normal structures of the organ, especially the lymphoid tissue. The tonsils, on examination, are seen to be enlarged, sometimes so much so as to meet in the middle line; they are pale in colour and firm in consistence; the crypts on their surface are enlarged, and are filled with a mucous secretion, which sometimes becomes caseous, and may be seen protruding from the crypts in the form of whitish plugs. These sometimes become infiltrated with lime salts, forming concretions. When much enlarged there is obstruction to the breathing; the child breathes with the mouth open, snores in its sleep, and speaks thickly. When the enlargement is moderate in amount, the principal inconvenience arises from repeated attacks of inflammation to which the child is liable, and which leave the tonsil larger after each attack. But when the tonsils have become considerably enlarged, they become the source of serious derangement to the general health. They spoil the voice, which becomes thick and husky; they impede the hearing; they prevent sleep except with the mouth open, and the child is apt to suddenly waken with a feeling of suffocation; and they obstruct respiration, so as to produce a partial vacuum in the chest, which leads to permanent deformity, imperfect aeration of the blood, and an interference with the general nutrition of the child.

Treatment.—In cases of slight enlargement of the tonsil it is advisable to try the effect of constitutional treatment before resorting to operation, especially if the child is very young; but if the enlargement is considerable there is only one effectual mode of treatment, by removing a part of the gland. The constitutional treatment consists in the internal administration of iron and cod-liver oil and strict attention to hygienic surroundings, with the local application of iodine or perchloride of iron and glycerine to the tonsil.

Tonsillectomy may be performed either by means of the bistoury or by a special instrument called a guillotine. Personally, I prefer to remove a part of the tonsil with the bistoury, as by this means the lower part of the organ, which often hangs down into the pharynx, can with certainty be removed, but very often escapes removal when the guillotine is used. To excise the tonsils with the bistoury in children, it is, however, necessary to administer an anæsthetic, whereas this is not always required in removing them with the guillotine if the fauces have been brushed over with a 10 per cent. solution of cocaine. In performing the operation with the bistoury the child is anæsthetised, and the mouth having been opened by means of a gag, the head is raised and allowed to rest against the shoulder of the anæsthetist, so that a good view can be obtained. The left tonsil is now seized with a volsellum, and the projecting mass cut off from above downwards, inclining the cutting edge of the knife slightly inwards as it cuts its way through, so as to avoid all risk of wounding the internal carotid artery. The instruments are now changed in the hands, the knife being held in the left and the volsellum in the right, and the other tonsil similarly removed. It is advisable to guard the cutting edge of the posterior part of the blade of the bistoury by winding a piece of lint around it, so as to avoid injuring the tongue or lips. In removing the tonsils with a guillotine, the patient, if old enough to submit to the operation without an anæsthetic, may be seated in a chair in a good light, and the tongue being held out of the way with a depressor, the ring of the instrument is passed over the projecting tonsil, which may be pressed into it by the finger pushing the parts inwards behind the angle of the jaw. By the pressure of the thumb on the cutting blade the projecting portion of the gland is at once removed.

The bleeding after removal of the tonsil is generally very slight, unless in attempting to remove too much the vessels of the soft palate are injured, or, what must be a very uncommon accident, the internal carotid artery is wounded. It should be borne in mind that all that is necessary is to cut off the projecting mass, and not to remove the whole tonsil. In performing this operation, it must be remembered that there are also in most cases adenoid vegetations in the naso-pharynx which will require removal (see page 632).

Syphilitic disease of the tonsil.—The tonsil may be the site of syphilitic disease in any of its three stages—as a chancre in primary syphilis, as an ulcer in secondary syphilis, or a gummatous infiltration in the tertiary form of the disease.

Malignant disease of the tonsil.—The tonsil is sometimes, though not very often, the seat of malignant disease, either sarcomatous or carcinomatous.

Sarcoma is the more common of the two; it is usually a lymphosarcoma, but, in addition to this, a round-celled sarcoma is occasionally met with. They form soft, rounded, rapidly growing tumours which project into the fauces and interfere with deglutition and respiration. They speedily infiltrate surrounding structures and implicate the lymphatic glands in front of the sterno-mastoid.

Treatment.—If seen and diagnosed early, these tumours may be removed from the mouth with very little hæmorrhage. The capsule is divided by the galvano-cautery, and the tumour shelled out. Recurrence is very likely to take place, and if the glands are implicated, and the surrounding structures involved, nothing can be done by operative means to relieve the patient.

Carcinoma of the tonsil is of the squamous-celled variety, and, unlike the sarcomata, rarely begins in the tonsil itself, but usually spreads to it from the tongue, fauces or palate. It forms a hard, indurated, rugged, ulcerated surface, with a sloughy base, and very rapidly involves the lymphatic glands.

Treatment.—In most cases the disease is too extensive to admit of operative interference, but if it is fairly limited an attempt to remove it from the neck may be undertaken. An incision is made down the anterior border of the sterno-mastoid, and a careful dissection carried down to the pharynx. All enlarged glands are removed. If sufficient room cannot be obtained, a second incision may be made from the angle of the mouth to join the first at the level of the hyoid bone, and the lower jaw may be cut through. The diseased mass is then isolated from surrounding structures and removed. A fair amount of success has attended these operations, and in selected cases there is no doubt that the attempt to remove the disease by these means is justifiable.

Relaxation of the uvula is frequently the result of chronic pharyngitis, and often produces considerable distress; from irritation of the back of the tongue and fauces causing constant cough and frequent vomiting. In slight cases painting with glycerine of tannic acid or a solution of nitrate of silver is sufficient to afford relief, but in inveterate cases the only cure is by removal of a portion of the uvula. Cocaine having been applied, the tip of the uvula is to be seized with a pair of clawed forceps and cut off with scissors. It is not necessary to remove more than half the uvula.

INJURIES AND DISEASES OF THE JAWS

Fractures of the superior maxilla, malar bone, and **zygomatic arch** are always the result of direct violence, and fractures of the malar bone and zygomatic arch rarely occur as independent lesions;

in nearly every case the superior maxilla is fractured at the same time. In many of these cases, where the fracture is produced by extreme violence, as in a gunshot wound or a kick from a horse, the bones of the face are extensively smashed and comminuted, and the fracture is compound. These injuries are followed by great deformity and distortion of the features, which it is often impossible to avoid. In other slighter cases a portion of the alveolus may be broken and either partially or completely detached. When the zygomatic arch is fractured, the displaced fragments may pierce the temporal muscle and interfere with its action.

Various complications may attend these fractures : severe hæmorrhage from wound of the internal maxillary artery or one of its terminal branches ; emphysema from the fracture extending into the antrum ; loss of sensation from injury to the supra-orbital nerve. As a rule union takes place very readily, but in cases of compound fracture involving the antrum, a sinus may persist, which is slow to close.

Treatment.—An attempt should be made to rectify the position of the fragments as far as possible, and this is especially the case where the fracture involves the zygomatic arch. The depressed bone can sometimes be elevated by manipulation from within the mouth. If not, it may be necessary to make an incision and elevate the fracture, and if this is in the zygomatic arch it would be desirable under these circumstances to wire the fragments together. When the alveolar process is involved, the fragment may be kept in position by wiring the teeth together, or by a carefully fitted dental plate. All movement of the jaws in mastication, speaking, &c., should be interdicted, and the patient fed on fluid food for two or three weeks.

Fractures of the lower jaw are almost always the result of direct violence. They are usually compound, sometimes from an external wound, but more usually from laceration of the mucous membrane of the gums from the displaced fragments. The bone may be broken at any part, but the most common situation is through the body of the bone, in the neighbourhood of the canine tooth, where it is especially weakened by the deep socket for this tooth, and the mental foramen. A somewhat rare form of fracture may occur at the symphysis from indirect violence, as when violence is applied laterally to the bone, compressing the two sides.

In fractures of the body of the bone, the larger anterior fragment is displaced downwards, by the muscles passing from the hyoid bone to the jaw. The smaller fragment is drawn upwards by the muscles of mastication, and is displaced outwards, so that it overlaps the anterior fragment.

The **symptoms** which characterise the injury are loosening and irregularity of the teeth, increased mobility of the fragments on each other, with crepitus, dribbling of the saliva, which is often mixed with blood from the laceration of the gums, and impairment of speech. In some instances the bone may be broken on both sides, and under these circumstances the central portion is dragged out of place by the muscles attached to the hyoid bone. There is usually considerable pain from the laceration of the sensitive gums, and probably also from injury to the branches of the inferior dental nerve. In the majority of cases the main trunk of the nerve escapes injury, as the fracture is a little in front of the dental canal. The fracture usually unites readily ; but in consequence of the laceration of the gums, some suppuration may occur at the seat of injury, and necrosis of a portion of the jaw may result.

In fractures through the angle or lower part of the ramus, there is usually little displacement, as the masseter on the outer side and the internal pterygoid on the inner side maintain the fragments in position. When the fracture passes through the neck of the jaw, the condyle is drawn forwards and inwards by the external pterygoid, while the body of the bone is drawn over to the opposite side, thus simulating dislocation. There is great pain in attempting to open the mouth, and in doing so crepitus is generally produced. Fracture of the coronoid process is a rare injury. The broken process is said to be drawn upwards and inwards by the temporal muscle, and union by bone to be impossible, but it is probable that in most cases no great displacement takes place, in consequence of the prolonged insertion of the tendon of the muscle as far as the last molar tooth, and there seems no reason to doubt that bony union usually takes place.

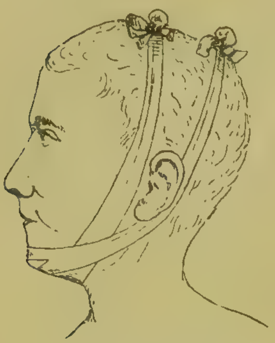
FIG. 253.—Four-tailed bandage for fracture of the jaw.

Treatment.—The treatment consists in replacing the fragments in position by manipulation, and maintaining them there for three or four weeks, during which time mastication must be forbidden. In the simpler cases this is by no means difficult; all that is required is to put up the parts in a four-tailed bandage. This consists of a piece of calico about three feet long and four inches broad, which is slit up at each end into two, leaving about eight inches in the centre undivided. A hole is cut in the middle to receive the chin, the two lower tails are then tied over the head, and the upper pair behind the occiput, and the four ends knotted together to prevent slipping (fig. 253). In cases where there is any difficulty in keeping the fragments in position, a gutta-percha or paste-board splint may be moulded to fit the chin, as shown in fig. 254, and this is applied under the four-tailed bandage. By these means the lower jaw is fixed against the upper, and the fragments maintained in position. It is clear, therefore, that no attempt at mastication should be made, but the patient must be fed on fluid or semi-fluid nourishment, which he can suck in between the teeth. In a period of from three to four weeks a little movement of the jaw may be allowed, and in five weeks the union may generally be expected to be fairly firm. In complicated cases, however, this treatment will not be found to be sufficient, and many different forms of apparatus have been invented for maintaining the fragments in position. Where there is only a single fracture, perhaps the best means is to wire the broken pieces by drilling a hole on each side of the injury, and fixing the fragments by means of thick silver wire. This plan should always be adopted in those cases where there is an external wound; but where there is not, it is by no means easy to drill the fragments. In order to do this, H. O. Thomas of Liverpool has devised a special tubular

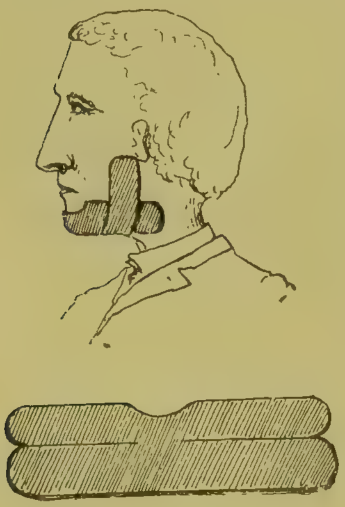
FIG. 254.—Gutta-percha splint for the treatment of fracture of the lower jaw.

needle. Where the fracture is multiple or comminuted, and the teeth or most of them remain in the jaw, the interdental splint of Hammond gives excellent results. A cast is taken of the teeth, and to this is moulded a firm wire framework, which is made accurately to surround the whole of the teeth, and the ends of which are annealed together. This is then placed in the mouth, encircling the teeth like a collar, and is fixed in position by several pieces of wire, which are passed around the teeth individually and fastened over the wire (fig. 255).

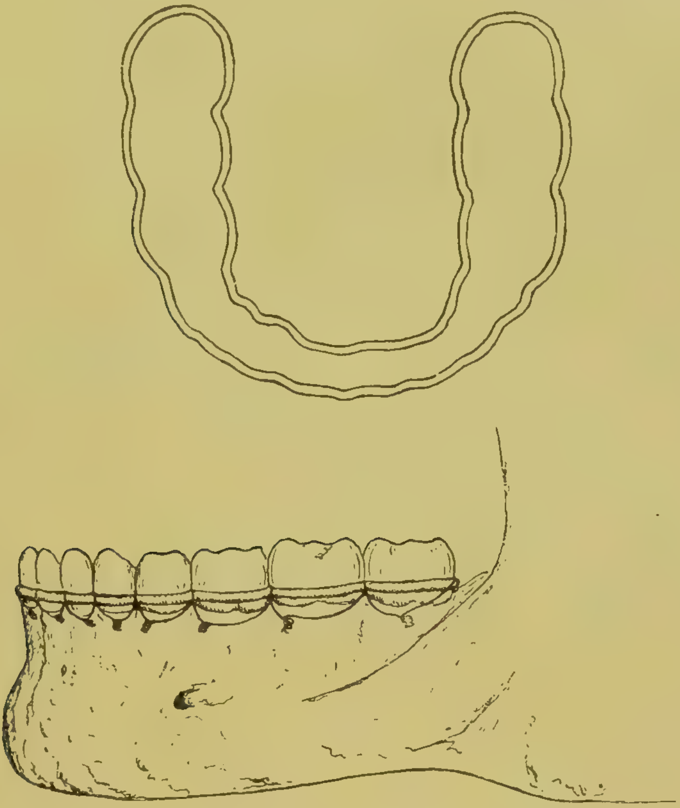

FIG. 255.—Hammond's interdental splint for the treatment of fracture of the lower jaw.

Binding the teeth on either side of the fracture together with silk or silver wire is sometimes adopted, but is not to be recommended, as it tends to loosen the teeth, and then becomes useless.

DISEASES OF THE GUMS

Hypertrophy of the gums consists in a general increase in thickness of the tissue of the gum, which is sometimes so considerable as to form a lobulated, vascular fold, growing up in front and behind the teeth, so as almost to bury them. No reason is known for this condition, which occurs principally in children or young adults. The only treatment consists in removing the exuberant growth with the knife, or destroying it with Paquelin's cautery.

Spongy gums.—In this condition the gums become swollen and congested, bleeding freely, and frequently becoming ulcerated around the teeth. They are very tender, and mastication is painful. The disease is often the result of scurvy, or may be due to the administration of mercury. It is also caused by stomatitis and dyspepsia, and is sometimes seen in ill-fed tuberculous children, accompanied by fœtor of the breath. The **treatment** consists in correcting the cause, and using a strong alum gargle.

Alveolar abscess is of common occurrence, and is almost always the result of decayed teeth. The simplest form is known under the name of *gumboil*, and is quite superficial. The deeper variety arises in the sockets of the teeth, and is due to septic changes in a decayed fang. The pus formed either perforates the wall of the alveolus, or finding its way over the edge forms a localised abscess under the periosteum, or else burrows beneath this membrane, forming an abscess of large size, which may eventually lead to necrosis of the jaw. If the abscess is situated in the lower jaw, it may track downwards under the periosteum, and point on the cheek at the lower margin of the bone. In the upper jaw the pus may burst into the antrum or track along the hard palate and lead to its necrosis. The symptoms consist in toothache, followed by swelling first of the jaw and then of the soft tissues of the cheek. The pain is of a very severe throbbing character. The swelling is hard and firmly fixed to the jaw, and there is often considerable œdema of the face and eyelids. Accompanying these local signs there is also considerable constitutional disturbance ; the temperature is raised, the tongue furred, and often the adjacent lymphatic glands become enlarged. The **treatment** consists in removing the offending tooth and applying warm fomentations. Often this is all that is necessary, and immediate relief is given. If not, the swelling beneath the periosteum should be incised through the mucous membrane from within the mouth to prevent an external opening being formed. In some cases where the disease has been allowed to go on without treatment the abscess will point externally, and must then be opened in this situation. Frequently in these cases a troublesome sinus will form, owing to the presence of a fragment of necrosed bone, and will not heal until this has been removed.

Pyorrhœa alveolaris is an inflammatory condition of the margin of the gums, followed by a gradual removal of the alveolus and a loosening of the teeth, which fall out, and the patient becomes edentulous. It is generally believed that the disease is constitutional, but little is known about its causation. It is accompanied by the formation of tartar on the teeth, which may be either the cause or the result of the condition. The treatment, which is unsatisfactory, consists in cleaning the teeth of the tartar and using an antiseptic mouth wash.

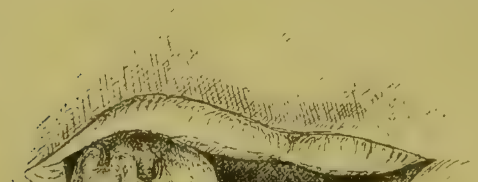
Fig. 256.—Epulis. (From a drawing in the Museum of St. George's Hospital.)

Epulis.—The term *epulis* was formerly applied to any tumour growing from the gums, but is now usually restricted to a fibrous growth, which springs from the periodontal membrane lining an alveolus, and is associated with the irritation of a decayed fang of a tooth. It consists of fibrous tissue covered externally by the mucous membrane of the gum, and it begins as an enlargement of the little tongue-like process of mucous membrane between two teeth. It gradually increases and forms a hard, fleshy, slightly lobulated mass, which may be either pedunculated or sessile (fig. 256). These tumours may attain a considerable size, and cause distortion of the dental arch, and even protrude from the lips. **Treatment.**—They should be excised, with the piece of bone forming the alveolus from which they spring, by means of a pair of cutting bone forceps. When thoroughly removed they rarely return.

Myeloid sarcoma (*myeloid epulis*) is a form of sarcomatous tumour which grows from the gum, and is sometimes termed *malignant epulis* from its tendency to recur after removal. It forms a soft, purplish tumour, which grows rapidly and speedily runs on to ulceration. The only treatment consists in removing the growth and the alveolar process of the jaw widely beyond the growth. When the tumour has not attained a large size, it may be possible to do this from within the mouth, by making a vertical section of the bone on either side of the growth by means of a small saw, and uniting them below with a chisel; but when the tumour is larger, it may be necessary to remove a portion of the whole thickness of the bone through an external incision.

Epithelioma of the gum is occasionally met with. It presents the ordinary characters of a squamous carcinoma, and has a tendency to spread along the periosteum and invade the bone, and in the upper jaw extend into the antrum without showing any tendency to fungate. It is therefore sometimes called *creeping epithelioma*. It is to be distinguished from myeloid sarcoma by this character; by the early period at which it ulcerates; and by the enlargement of the neighbouring lymphatic glands. The treatment consists in excising the growth and the bone to a considerable extent around. Where the disease has invaded the antrum, it will be necessary to remove the whole of the upper jaw except its orbital plate.

Necrosis of the jaw is of common occurrence, and may arise from a variety of causes. (1) It may follow injury, generally where the bone is broken and the fracture is compound, either through the cutaneous or mucous surfaces, and septic periostitis is set up. (2) It may result from alveolar abscess, under which circumstance the amount of bone which dies is limited and involves only a superficial layer of bone. (3) Necrosis of the *upper* jaw is of not infrequent occurrence in tertiary syphilis, when it usually attacks the palate process. (4) Formerly necrosis of the jaw was of common occurrence from mercurial poisoning, but these cases are rarely met with in the present day. (5) Phosphorus necrosis was also a common disease in former days among makers of lucifer matches, but since red amorphous phosphorus has been substituted in their manufacture for the ordinary yellow phosphorus the disease is much less common. The condition arises from the effects of the fumes of phosphorus on the exposed bone around a carious tooth, and is characterised by an inflammation which terminates in necrosis, and the formation of an investing shell of porous bone over the necrosed fragment. The disease is very insidious, and may involve large tracts of both upper and lower jaw. The necrosed bone assumes the porous character and greyish colour of pumice stone, and is slow in separating. (6) Necrosis of the jaw is an occasional sequel to the acute exanthemata, especially scarlet fever. In these cases the whole of the lower jaw may become involved, and may lie loosely in a bag of pus formed from the periosteum. If the dead bone is removed, a complete reproduction of the jaw may take place. (7) Necrosis of the jaw sometimes occurs in tuberculous children.

Symptoms.—Necrosis of the jaw generally begins with acute inflammatory symptoms. The affected part of the face becomes swollen, red and shiny, and severe pain is complained of. This may be at first mistaken for toothache, but sooner or later an abscess forms, either in the mouth or on the face, or the pus may burrow down into the neck. The breath is very offensive, and there is considerable constitutional disturbance, especially in the phosphorus necrosis, in which, in exceptional cases, pyæmia and abscess of the brain may supervene. After the abscesses have been opened or burst, sinuses form which discharge fœtid pus and on probing dead bone will be felt.

Treatment.—Incisions should be made as soon as matter forms, and free drainage provided for. The abscess cavities should be kept as aseptic as possible by repeated syringing with antiseptic solutions, and the necrosed bone removed as soon as it is loose, if possible through the mouth.

DISEASES OF THE UPPER JAW

Suppuration in the antrum in the great majority of cases is due to inflammation around the fang of a carious tooth, especially the second bicuspid, or one of the first two molars, but may occasionally arise from injury or extension from adjoining parts. It may be acute or chronic. In the *acute* cases it is attended with deep-seated pain, rapid swelling, redness and œdema of the cheek and lower eyelid, and very often epiphora, and is accompanied by considerable constitutional disturbance. In the *chronic* form there is a dull aching pain about the antrum, and the gums and mucous membrane of the nasal fossa are red, swollen and tender. There is usually an intermittent discharge of pus from the nose, which is often very offensive, and may be mistaken for ozæna, but according to Heath the fœtor is only apparent to the patient and not to others. The pus trickles from the nostril when the patient's head is bent forwards, and into the pharynx when he is in the recumbent position. In some cases the opening of the antrum becomes occluded, and the pus then distends the cavity and causes the bony walls to expand. In this way a swelling may be formed on the cheek beneath the malar eminence; or the floor of the orbit may be bulged upwards, producing exophthalmos; or the palate may be depressed; or the nasal wall may be bulged inwards, causing obstruction to the breathing.

In some cases, which are known as 'latent empyema of the antrum,' pus may form in the cavity and give rise to scarcely any symptoms.

The **diagnosis** of these cases is not readily made, and it has been recommended under these circumstances to illuminate the cavity. A small electric lamp is introduced into the mouth while the patient is in a dark room, and if the antra are normal, the cheeks and lips will be of a rosy red in many individuals, but not in all. But if the cavities are filled with an opaque fluid such as pus, or by a solid growth, this illumination is not apparent. As the test does not answer in every individual, all that can be said for it is that the presence of the illumination negatives any foreign matter in the antrum, but its absence by no means indicates any abnormal condition. Perhaps the most characteristic symptoms of empyema of the antrum is the periodic discharge of pus from the nose. When a patient applies to the surgeon with the history that he gets periodical attacks of discharge of pus from the nose, which may or may not have been preceded by a dull aching pain in the situation of the antrum, the presence of this disease is indicated, and if on examination one of the præmolar or molar teeth is carious the presumption is very strong, and an exploration of the antrum should be made with an exploring syringe.

Treatment.—The treatment consists in establishing a free exit for the pus. This is best done by making an opening from the mouth through the anterior wall of the antrum in the situation of the canine fossa. A considerable portion of the anterior wall should be cut away, so as to leave a large opening, and the cavity of the antrum scraped. The carious tooth, if one exists, should also be extracted. In many cases the cavity rapidly closes, but in others a persistent sinus remains. In these a small silver style should be fitted into the opening and retained by a collar round one of the teeth. This should be taken out daily and the cavity syringed.

Tumours of the upper jaw may be cystic or solid, and the latter may be innocent or malignant.

Cystic tumours.—Several different forms of cystic tumour are met with in the upper jaw. Among these are:

1. **Retention cysts,** cystic tumours caused by the obstruction of a mucous follicle in the lining membrane of the antrum. These tumours were formerly known under the name of *dropsy of the antrum*, and were supposed to be due to a blocking up of the opening leading into the nasal fossæ, and a collection of the secretion of the lining membrane of the antrum in the cavity. They are now known to be true cystic tumours. As they grow they cause expansion of the walls of the cavity, and produce prominence and swelling of the cheek, and an indolent semi-elastic tumour, which on palpation gives rise to egg-shell crackling, and later on to distinct fluctuation. The condition is painless. In some cases bulging of the roof of the mouth or floor of the orbit may be present. The fluid in the cyst is of a glairy mucoid character, very similar to that found in a ranula; in fact, as regards its pathology the disease is identical with ranula.

Treatment.—The only successful method of treating these cases is to establish a permanent opening into the cyst. This is done by incising the mucous membrane over the anterior wall of the antrum from inside the mouth and cutting away a portion of the bone, so that the cavity can be syringed out daily with some antiseptic solution.

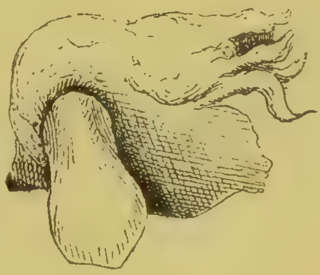

FIG. 257.—A portion of the lining membrane of a dentigerous cyst of the upper jaw, with a tooth implanted in it. (From the Museum of St. George's Hospital.)

2. **Dental cysts** are cysts formed in connection with the fang of a tooth. They are inflammatory in their origin, and often contain pus. They are developed beneath the periosteum of the fang, and therefore, in extracting the tooth, the sac or cyst, which may vary from the size of a pea to a pigeon's egg, is often drawn out with it. Occasionally they may attain a larger size and invade the antrum. The treatment consists in laying open the sac and draining.

3. **Dentigerous cysts** are cysts formed around a tooth or teeth which have been imperfectly developed and are retained in the jaw. They are more common in the lower jaw, but occasionally are found in the upper jaw, where they invade the antrum (fig. 257). They will be considered with tumours of the lower jaw.

4. **Multilocular cysts** in the form of fibro-cystic tumours or cysts in malignant tumours are occasionally met with in the upper jaw, but far more commonly in the lower.

Solid tumours of the upper jaw may grow either from the periosteum covering the surface of the bone or from the mucous membrane or periosteum lining the antrum. They may be either innocent or malignant. The **innocent** are: 1. *Fibroma*, which is not uncommon, and which grows either from the antrum or surface of the bone. 2. *Osteoma*, perhaps the most common, consists of compact bone, which, usually growing within the antrum, fills it and causes an expansion on the cheek. Many cases, which have been described as osteomata, are probably examples of leontiasis ossia (see page 485). 3. *Chondroma* is a third form of tumour, occasionally met with in the upper jaw. The **malignant tumours** are the sarcomata and carcinomata. The **sarcoma** is perhaps the more common, and is usually of the spindle-celled or round-celled variety, growing either from the anterior wall or the cavity of the antrum, or in some cases springing from behind the bone and speedily invading it. It forms a rapidly growing tumour which projects on to the cheek and into the nose, forming polypoid growths, which bleed (fig. 258). It rapidly invades other structures and destroys the bones. The **carcinoma** is also not uncommon. It occurs as two different varieties—as a squamous epithelioma when it grows from the gums or hard palate, or as a columnar-celled epithelioma when growing from the cavity of the antrum or the nasal fossæ.

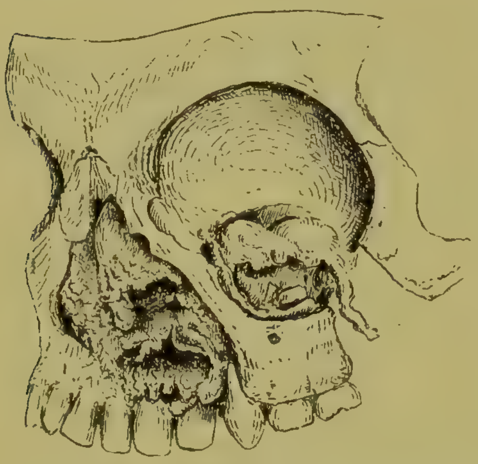

FIG. 258.—Sarcoma of the nasal fossæ, invading the antrum and orbit. (From the Museum of St. George's Hospital.)

In the **diagnosis** of tumours of the upper jaw, three points have to be taken into consideration: (1) to diagnose the fluid from the solid swellings; (2) to diagnose the innocent from the malignant growths; (3) to determine the site from which the tumour sprang.

1. In both the fluid accumulations in the antrum and solid tumours of the upper jaw there is a considerable swelling of one side of the face, forming generally a smooth round or oval tumour; and in addition to this there may be bulging of the roof of the mouth or floor of the orbit, the nasal cavity may be encroached upon, and it is often very difficult or impossible to determine whether this is due to a fluid or solid enlargement without an exploratory puncture. This should never be omitted in cases in which there is any doubt. In some instances the history of the case, the elasticity, or even fluctuation, with the characteristic egg-shell crackling, is sufficient to establish a diagnosis.

2. The diagnosis between an innocent and a malignant tumour is almost impossible as long as the disease is confined to the antrum and has not perforated its walls. The points chiefly relied upon in establishing a diagnosis are the rapidity of the growth, the age of the patient, and the implication of neighbouring lymphatic glands. When, however, the growth has penetrated the walls of the cavity, its nature soon becomes

evident; it grows with alarming rapidity; encroaches on the nasal and orbital cavities; implicates the soft structures of the face and mouth, and fungates.

3. In investigating malignant tumours of the jaw, it is of essential importance as regards treatment to endeavour to ascertain whether the primary seat of the growth is from the interior of the antrum or from structures situated behind the maxillary bone, and this can only be done in the early stage of the disease. Then, if the disease has commenced in the antrum, the walls of the cavity are displaced and there are projections into the buccal, nasal, or orbital cavities, with irregularity in the line of the teeth; whereas, if the disease has commenced behind the bone, these projections are absent, and there is no alteration in the line of the teeth. Later on, the growth may find its way into the antrum and expansion takes place, and then the diagnosis of the site of origin of the growth is impossible.

Treatment.—The only treatment applicable to solid tumours of the upper jaw is free extirpation of the growth, which usually necessitates the removal of the whole or a portion of the maxilla. Where the tumour has spread beyond the limits of the antrum, and has invaded the tissues of the cheek, the surgeon should be quite clear in his own mind that he can extirpate the whole of the growth before attempting its removal. When, however, the tumour is confined to the antrum, and there is no implication of the neighbouring lymphatic glands, the whole superior maxillary bone may be removed, with a fair prospect of prolonging the life of the patient. In those cases where the disease begins behind the maxilla, pushing the bones of the side of the face forwards, it is doubtful whether an operation can be undertaken with much prospect of success; but if the patient is young, and his general health good, it may be right to attempt the removal of the tumour, by first excising the superior maxillary bone, and then extirpating the tumour from the cavity behind.

Excision of the upper jaw. The patient is placed in the recumbent position, in a good light, with the head and shoulders well raised. The central incisor tooth of the side to be removed is first extracted. An incision is made from a point just below the inner canthus of the eye, down the side of the nose and round its ala to the middle line of the lip, and then through the centre of the upper lip (fig. 259). A second incision is made from the malar bone along the lower border of the orbit to the commencement of the first incision. The lip and cheek are now raised and turned outwards, exposing the bone. Any bleeding vessels are to be secured before proceeding with the next step of the operation.

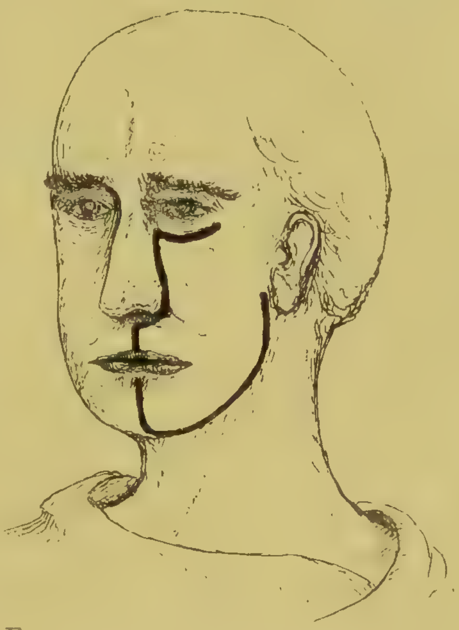
FIG. 259.—Incisions for removing the upper and the lower jaw.

Prior to dividing the bony attachments, it is wise to incise the periosteum along the lower margin of the orbit, and then with the handle of the scalpel to separate this membrane from the floor of the orbit; for in all cases the periosteum of the orbital cavity should be left intact. The mouth is now widely opened with a gag, and an incision is made along the middle line of the hard palate down to the bone as far as its junction with the soft palate, and is then carried outwards so as to divide the soft palate from the hard.

The surgeon now proceeds to divide the bones, having first separated the ala of the nose from its bony attachment. This he does partly by means of a narrow saw, partly with strong cutting pliers. (1) He first saws through the bone at its junction with the malar bone, carrying his incision backwards so as to fall into the spheno-maxillary fissure. After a deep groove has been made in the bone, the separation can be completed with forceps. (2) By placing one blade of the forceps inside the nostril, and the other on the outside of the bone, he divides the nasal process of the superior maxilla at the lower margin of the orbit. (3) The saw is introduced in the nasal cavity, and the palate processes of the palate and superior maxillary bones sawn through close to the septum nasi, and the alveolar process through the socket of the extracted tooth. The bone is now seized with a pair of lion forceps, one blade seizing the alveolar process inside the mouth, and the other the infra-orbital margin, and by an upward and downward movement the remaining bony attachments are broken, and the bone twisted out; the line of fracture running across the vertical plate of the palate bone and the pterygoid plates.

Upon the removal of the bone there is often considerable hæmorrhage from branches of the internal maxillary artery which are torn through, but this can usually be arrested by firmly plugging the cavity for a few minutes with a sponge.

After the removal the cavity left behind should be thoroughly explored, to discover if any particles of growth have been left behind, and if so they should be dealt with by means of a sharp spoon or a Paquelin's cautery. After all bleeding has ceased, the surface of the wound should be swabbed over with a solution of chloride of zinc (gr. xl to ℥j). If any oozing is going on, the cavity should be plugged with a long strip of cyanide gauze, the end of which is left protruding from the mouth. This should be removed at the termination of twenty-four hours. The edges of the wound are brought accurately and carefully in apposition with one or two fishing-gut sutures, which act as 'main-stays,' and numerous horsehair sutures, and it is dressed with gauze secured with collodion and the usual dressing.

During the operation, after the first incisions have been made, the patient should be only kept slightly under the influence of the anæsthetic, so as not to completely destroy the sensibility of the glottis, and prevent blood from finding its way into the air passages.

After the operation the patient should be kept propped up and fed for the first few days by the rectum, or by a tube passed into the pharynx, and the mouth should be constantly washed out with an antiseptic solution. Healing is by granulation, and often takes place very rapidly. When it is completed, an obturator and tooth plate will be required.

Partial extirpation of the upper jaw.—In many cases of innocent tumour of the upper jaw it is not necessary to remove the whole bone, and in every case the endeavour of the surgeon should be to remove as little as possible, in order to minimise the resulting deformity. This especially applies to the orbital plate, which should always be left when possible so as to support the eye and prevent its downward displacement.

In cases of epulis the alveolar process, or a part of it, only requires removal, and this may be done either from the mouth without external incision, or by division of the lip in the middle line. When the lower part of the bone requires removal, it may be done by dividing the lip in the middle line and carrying the incision around the ala of the nose, separating it from the bone. By dissecting up the flap of cheek, the lower part of the bone can be exposed and removed by a horizontal saw cut. If the whole of the bone except the orbital plate requires removal, the external incisions should be the same as those for the removal of the whole bone, and after division of the alveolus and palate a saw cut is made from the anterior nares across the bone, just below the infra-orbital foramen, and the lower part of the bone removed.

DISEASES OF THE LOWER JAW

Tumours of the lower jaw, like those of the upper, may be either cystic or solid. The cystic tumours are: (1) the **dental cysts,** which are similar to those found in the upper jaw; (2) the **dentigerous cysts,** which, though occasionally found in the upper jaw, are much more common in the lower. They arise from imperfectly developed teeth, which have been retained in the jaw. A tooth during development becomes displaced, very often horizontally, so that it cannot erupt, and a cavity develops around it, which expands the bone (fig. 260). The cyst contains clear fluid, is lined by epithelium, and a more or less developed tooth is found generally embedded in the wall of the cavity (fig. 257). Sometimes more than one tooth is present. They are usually met with in young people, but may occur later in life. At first the tumour is hard and feels solid, but as the bone expands it becomes thinned, and then egg-shell crackling may be perceived, and later on true fluctuation. On examining the denture one of the permanent teeth will be found missing from the series, and there will be no history of its having been extracted. Occasionally suppuration may take place in the cavity. This will lead to the formation of a sinus, which will not heal until the non-erupted tooth is removed. The treatment consists in excising a portion of the wall of the cyst from the mouth and extracting the misplaced tooth. The interior of the cyst is then to be thoroughly scraped, and flushed with an antiseptic solution and packed with gauze. If the wall of the cyst is sufficiently thin to allow of it, it should be crushed in with the hand before it is packed, and thus the size of the cavity, which has to heal by granulation, is materially diminished. (3) The **multilocular cysts** are more common in the lower than in the upper jaw. They may be fibro-cystic tumours or cysts developed in adenomatous or sarcomatous tumours. The fibro-cystic

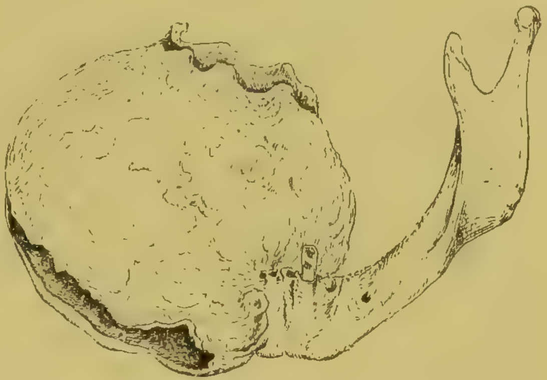

FIG. 260.—Large dentigerous cyst of the lower jaw. (From the Museum of St. George's Hospital.)

tumour consists of growths, often of considerable size, made up of a number of cysts, with more or less solid matter between them. The solid portion consists of columns of epithelial cells, resembling those of the gum, bound together by a fibrous stroma, and the cysts are due to colloid degeneration of these columns. They contain a viscid, yellowish fluid.

The **treatment** consists in the removal of the portion of the bone from which they grow, together with the tumour itself.

Solid tumours of the lower jaw include the same varieties as were noted as occurring in the upper jaw: among innocent tumours, fibromata, chondromata and osteomata; and among malignant tumours, sarcomata and carcinomata. The **sarcomata** are met with in the lower jaw, as myeloid, spindle-celled, and round-celled. The myeloid occurs not only as the malignant epulis (see page 671), but also as a central growth, generally in the horizontal portion of the bone, which it expands (fig. 261). It is perhaps of all forms of myeloid tumour the least malignant, and in many cases a cure may be effected by cutting away the outer shell of bone, scraping away the new growth and swabbing out the cavity with carbolic acid. In other cases it may be necessary to remove the portion of jaw from which it grows, but when this is done it is always desirable, if possible, not to cut through the whole depth of the bone, but to leave a bridge at the lower border, so as to preserve the outline of the bone and prevent deformity. The round- or spindle-celled sarcomata spring from the periosteum, and are much more malignant. In these cases nothing but wide removal of the bone is of any avail.

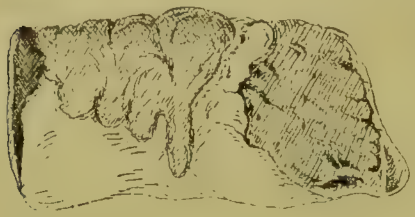

FIG. 261.—Myeloid tumour of the lower jaw. (From the Museum of St. George's Hospital.)

Carcinoma of the lower jaw occurs only as a squamous-celled epithelioma, generally arising from an extension of disease from the tongue, lips, or gums, and requires removal of a portion of the jaw, together with the primary disease.

Excision of the lower jaw is required in the treatment of tumours arising from this bone or secondarily implicating it.

In these cases the disease seldom extends beyond the middle line, so that the operation may usually be limited to excision of the bone on one side of the face, and may consist in removal of one half of the bone or a portion of it. Where the disease involves the horizontal ramus as far back as the angle, it is always a question whether the half of the bone should be removed at the temporo-mandibular joint by disarticulation, or whether the vertical ramus should be cut through horizontally, and the coronoid and condyloid processes left, but in the majority of cases it is safer to remove the bone by disarticulation.

Removal of half the lower jaw.—The patient is placed in the recumbent position, with the head and shoulders well raised, in a good light. The central incisor on the side affected is first extracted. An incision is then made from the central point of the lip over the chin to just below the symphysis of the jaw. If the growth is not very large, it is not always necessary to divide the red margin of the lip, but to commence the incision immediately beneath, though in the majority of cases it is better to do so, as the additional deformity is not great, and proceedings are much facilitated by adopting this course. The incision is then carried along the lower border of the jaw to the angle. In doing this the facial artery and vein will be divided, and should be seized with clip forceps and at once tied. The incision is now carried upwards along the posterior border of the ramus of the jaw to a little below the lobule of the ear (fig. 259). The flap thus formed is now raised from the bone by dividing the reflection of mucous membrane from the lip on to it, and the muscles attached to its external surface, including the masseter. The jaw is then divided by sawing the bone, through the socket of the extracted incisor tooth By dividing the bone a little to one side of the symphysis the attachment of the genio-hyo-glossus to the upper genial tubercle is not interfered with, and thus all danger of the tongue falling back upon the larynx and choking the patient is prevented. The knife is now inserted inside the bone, and the mucous membrane reflected from the floor of the mouth on to the jaw divided close to the bone, together with the fibres of the mylo-hyoid and the anterior belly of the digastric. The bone can now be seized in the left hand of the operator and everted so as to enable him to divide the fibres of attachment of the internal pterygoid. After this, by depressing the bone the coronoid process can be brought into view, and the insertion of the temporal muscle into it divided, together with the inferior dental vessels and nerve. After the temporal muscle has been completely severed, the only remaining step of the operation is the disarticulation of the condyle, and this will have to be effected with caution to avoid wounding the internal maxillary artery. By strongly depressing the bone, without any eversion or rotation, the front of the capsule of the joint can be opened with the point of the knife, and the rest of the capsule with the lateral ligaments divided from within, keeping the knife close to the bone. By means of a raspatory the external pterygoid should be separated from its attachment to the neck of the condyle, and the bone will now be free and can be removed. All hæmorrhage is arrested, and the flap brought down and sutured with one or two silkworm-gut and plenty of horsehair sutures, taking care that the red line of the lip is accurately adjusted. The wound is then covered with collodion and gauze, and dressed in the ordinary way. The patient is fed for a few days by nutrient enemata, or by a tube passed through the nose into the stomach, and the mouth frequently washed out with weak antiseptic solutions.

Removal of a portion of the lower jaw may be required in cases of new growths limited in character. This may be done by making a horseshoe-shaped incision, with its concavity upwards, and sawing through the bone in two places, beyond the margin of the growth. The operation is attended with considerable deformity if the whole depth of the bone has to be removed, from falling together of the fragments. An attempt to obviate this should be made by adapting a wire framework to keep the fragments apart until consolidation has taken place. A Hammond interdental splint (see page 669) is best adapted for this purpose.

Odontomes.—In connection with the subject of tumours of the jaws must be mentioned a collection of tumours which result from some peculiar modification in the growth of a tooth, and which are known as *odontomes*. These tumours have been studied and described by Bland Sutton, from whose work the following account has been extracted. He states that there are seven different varieties, determined according to the part of the tooth germ from which they arise. 1. **Epithelial odontomes.**—These originate from the enamel organ and consist of encapsuled tumours, generally of the lower jaw, made up of a congeries of cysts containing mucoid fluid. The cysts are lined by epithelium. They occur for the most part in young subjects, and may attain a considerable size. 2. **Follicular odontomes.**—These are the dentigerous cysts already described. 3. **Compound follicular odontomes.**—Where more than one tooth is unerupted and their capsules become confluent, a multilocular cyst is formed constituting a compound follicular odontome. 4. **Fibrous odontomes.**—These consist of a thickening of the capsule which encloses each tooth before eruption. The tumours are composed of laminæ of fibrous tissue, intermingled with calcareous matter. They are liable to be mistaken for myeloid sarcomata. 5. **Cementomes.**—These are bony tumours resembling cementum, which originate from the ossification of the fibrous odontome. These tumours have not hitherto been found in man, but occur in the horse. 6. **Radicular odontomes** are outgrowths of dentine and cementum from the root. 7. **Composite odontomes.**—Masses arising from abnormal growth of all the elements of a tooth germ and consisting of a conglomeration of dentine, enamel and cementum. They are most common in the upper jaw.

INJURIES AND DISEASES OF THE TEMPORO-MANDIBULAR JOINT

Dislocation of the lower jaw.—The lower jaw is only dislocated in one direction, namely forwards, unless accompanied by fracture (fig. 262). It may be dislocated on both sides at the same time, the *bilateral* dislocation; or one side only may be dislocated, the *unilateral.* The former is the more common of the two in the proportion of three to two.

The dislocation can only take place when the mouth is widely open. When this is so, the condyle of the jaw is situated on the eminentia articularis, and very slight force, or even muscular action, may cause it to become displaced forwards by tilting it over the summit of the ridge. It may thus become dislocated during the act of yawning, shouting, or vomiting, by the spasmodic action of the external pterygoid, or by a blow on the side of the jaw while the mouth is open, or in extracting a tooth, or passing a stomach-pump tube, or taking a cast of the mouth.

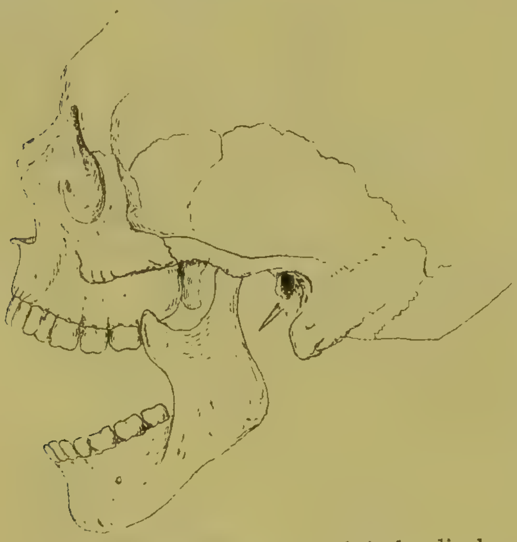
FIG. 262.—Diagram showing the displacement in dislocation of the lower jaw.

Symptoms.—When the dislocation is bilateral the mouth is widely open and cannot be closed, and the lower jaw is advanced in front of the upper, so that the chin is carried forwards, and the face, when viewed in profile, appears to be elongated. The lips cannot be approximated, and therefore speech and deglutition are impaired, the labial consonants not being pronounced and the saliva constantly dribbling from the mouth.

The cheeks are flattened, and a hollow can be felt in front of the external auditory meatus. An oblong prominence can be defined in front of the hollow, which may be recognised as the condyle by a slight movement being felt in it on making passive motion.

When the dislocation is unilateral the symptoms are much less marked; the chin is inclined to the opposite side to that on which the dislocation has taken place. The condyle can be felt in its natural situation on the sound side, and a certain degree of movement is possible.

Treatment.—The dislocation can usually be reduced by seating the patient in a chair, standing in front of him, and inserting the thumbs, guarded by a napkin, into the mouth, so as to press the lower molar teeth downwards and backwards, and at the same time elevating the chin with the fingers. Some surgeons introduce the end of a piece of wood about a foot long between the molar teeth, and by raising the other end, the point, resting on the lower molars, is depressed, the upper teeth acting as a fulcrum, and the jaw is levered back into its place. Nélaton believed that difficulty in reduction depended upon the coronoid process becoming hitched against the malar bone. He recommends that reduction should be effected by introducing the thumbs into the mouth and pressing the ramus directly backwards.

After reduction the jaw is to be fixed with a four-tailed bandage, and passive motion carefully and regularly applied. The jaw having once been dislocated is very liable to become again displaced, and in some cases the structures around the joint become so lax that the accident is constantly recurring.

Acute synovitis is not an uncommon affection, occurring, in children, as a sequel to the exanthemata, especially scarlet fever, and, in adults, after rheumatic fever. It may also originate from injury. The symptoms are those of inflammation; pain, greatly increased by any movement of the jaw, with heat, swelling and redness in front of the lobule of the ear. The disease is usually accompanied by considerable febrile disturbance. It usually terminates in resolution, but may go on to fibroid thickening of the capsular and other ligaments and impaired motion; or in some cases it may run on to suppuration, especially in children, after scarlet fever, when suppuration in the tympanum has followed.

Treatment.—The treatment consists in keeping the jaw at perfect rest by means of a four-tailed bandage and applying hot fomentations. A leech or two over the articulation will often greatly relieve the pain. The patient must be kept on fluid diet.

Acute arthritis may be the sequel of acute synovitis, and also occasionally occurs as a pyæmic condition and as a gonorrhœal affection. It begins with the ordinary symptoms of synovitis, followed after a time by increased throbbing pain and swelling and generally a rigor, and matter points immediately over the joint. The **treatment** consists in early antiseptic evacuation of the pus and free drainage. Occasionally the condyle dies and requires excision at a later date.

Osteo-arthritis.—The temporo-mandibular articulation is one of the joints which is prone to be the seat of osteo-arthritis. It usually occurs after middle life, but is also not uncommon in anæmic women of middle life. It may be bi- or uni-lateral. The joint undergoes the usual changes found in this disease: the interarticular and articular cartilages disappear; the glenoid cavity becomes enlarged and flattened and its margins lipped, with the formation of osteophytic outgrowths, and the condyle becomes eroded. The disease is characterised by aching pain in the joint, which is worse at night and in damp weather; there is enlargement and deformity in front of the tragus of the ear, and grating on moving the joint. When the disease is unilateral the chin is deflected to one side. Occasionally a partial displacement of the condyle takes place if the patient incautiously opens the mouth widely, causing pain and discomfort.

Treatment.—The treatment is unsatisfactory. Counter irritation sometimes affords a certain amount of relief, and attention should be paid to preserving as far as possible the movements in the joint. In the later stages excision has been attended with satisfactory results.

Closure of the jaw may be due to several different conditions. (1) *Spasm of the muscles* of the jaw, induced by irritation of the third division of the fifth cranial nerve from an impacted wisdom tooth, or carious teeth or some other local condition, producing spasm of the muscles of mastication. Closure of the jaw is also sometimes simulated in hysterical women. The condition is known as *trismus*, and is usually remedied by removing the cause. (2) Inability to open the jaw often arises from *inflammatory conditions*, such as alveolar abscess, mumps, &c. (3) *Contraction due to cicatrices* is another cause of closure of the jaws. These contractions may be due to the healing of extensive sloughing from cancrum oris, or to scars on the cheek from burns or extensive lupus or gunshot injuries. It may also arise after extensive operations for the removal of epithelioma or rodent ulcer. (4) Closure of the jaw may be due to *ankylosis* of the temporo-mandibular joint from disease in this articulation. The ankylosis may be fibrous or bony, and the diagnosis between the two can generally be made when the patient is under an anæsthetic. In some cases when the ankylosis is not very firm, the adhesions may be broken down by forcibly opening the jaws under an anæsthetic, but the operation is frequently attended with unsatisfactory results, as it is exceedingly difficult to prevent reunion. In the majority of cases some cutting operation will have to be resorted to. The two operations usually performed are: (1) Esmarch's operation of removal of a wedge of bone from the neighbourhood of the angle of the jaw; (2) excision of the condyle.

1. **Esmarch's operation** is generally to be preferred, especially when there are scars in the neighbourhood of the condyle, which render excision not only difficult, but useless; or when there are cicatrices within the mouth from destruction of the mucous surface. An incision is made about 2 or 2½ inches in length along the lower border of the jaw from the angle. The soft parts are then raised from the bone as far as the alveolar border, and a triangular wedge of bone, with its periosteum, is sawn out; the apex of the wedge corresponding to the alveolar border. After the operation passive movement must be commenced early.

2. **Excision of the condyle.**—An incision should be made along the lower border of the zygoma, from the tragus, forwards for about an inch and a half. The deep fascia having been divided, the parotid gland and with it the facial nerve is drawn downwards by blunt hooks, and the masseter exposed. The fibres of this muscle are now separated from their attachment to the zygoma, and the neck of the condyle exposed. This is cut through with strong bone forceps, or divided with a fine saw, and the condyle seized with a pair of lion forceps, and dissected out by severing the ligaments and fibres of the external pterygoid muscle, care being taken to keep the point of the knife close to the bone. The interarticular

cartilage is left. Passive motion must be carefully carried out for some long period after the operation, as relapses are very liable to occur. Mears recommends that a more extensive operation should be performed, and that the line of section of the bone should be in the ramus, some little distance below the sigmoid notch, so that the coronoid process is removed as well as the condyle. This operation would appear to be less frequently followed by relapse than excision of the condyle alone.

CHAPTER IX

INJURIES AND DISEASES OF THE EAR

For convenience of description it is customary to divide diseases of the ear into those of the auricle and external meatus; those of the tympanum, including the Eustachian tube and mastoid cells; and those of the labyrinth.

Injuries of the external ear.—The external ear is liable to be contused, especially during the game of football, and this is often attended by an effusion of blood between the cuticle and perichondrium on the anterior surface of the auricle. It constitutes what is termed a *hæmatoma auris*, and may occur spontaneously and independent of injury. From its frequent occurrence in the insane, it used to be regarded as peculiar to them. The auricle becomes enlarged, swollen, and of a bluish-red colour; hard to the touch, and rarely fluctuating. As a rule it is desirable not to meddle with these cases; but if they are painful or become inflamed, an antiseptic incision should be made, the contents turned out, and the wound dressed antiseptically.

Wounds.—The external ear is sometimes wounded in injuries of the scalp. A flap of the scalp may be torn down carrying the external ear with it, or a portion of the auricle may be torn from the rest, and remain hanging by a small tag of tissue. Under these circumstances it should never be removed, but after careful cleansing should be accurately adjusted by several points of suture.

Foreign bodies in the meatus.—Foreign bodies are frequently introduced by children into the external auditory meatus, and may give rise to very considerable trouble. The foreign body is generally tightly wedged in the meatus, close to the membrana tympani, and any attempt to remove it with instruments is attended with a risk of injuring the membrane or cuticular lining of the meatus, which may be followed by serious results. It is only, therefore, in cases where the foreign body is lying close to the external opening, does not completely fill the canal, and is of a soft nature, like a roll of paper, that any attempt should be made to extract it by forceps, sharp hook, &c. In the majority of cases, injections of warm water should be used, and in many instances this will succeed in bringing away the body at once; but should it not, it will probably do so in the course of a few days, after repeated injections. The child should be anæsthetised, and the auricle pulled upwards and backwards, with the head placed so that the ear is in a dependent position, and a forcible jet of water thrown along the roof of the canal. The water penetrates behind the foreign body, and in most instances dislodges it. In those rare cases where this does not succeed, careful efforts may be made to extract it; but this should never be done unless the child is under an anæsthetic and the parts can be thoroughly illuminated.

Malformations.—The pinna may be congenitally absent, and in some cases the external auditory canal closed. In these cases no surgical interference is desirable, as it is generally found that when the external ear is deficient the middle or internal ear is defective as well. Moreover, any operation undertaken to form an auditory canal generally proves unsuccessful, and the artificial opening closes. Occasionally *accessory auricles* are met with, and sometimes branchial fistulæ are associated with them in the situation of the visceral clefts. They may be removed.

Hypertrophy, or protuberance of the auricles, is sometimes met with. The condition may be remedied by removing V-shaped portions of the skin and cartilage from the ear posteriorly, and uniting the edges of the incisions with sutures.

Diseases of the auricle.—The auricle is sometimes the seat of skin-eruptions, especially *eczema*, which is often troublesome and difficult to cure, on account of the tendency there is for the secretion to accumulate in the recesses, and the difficulty there is in keeping the parts clean and dry. It occurs mostly in gouty subjects or in tuberculous children.

The **treatment** consists in carefully cleansing and drying the ear at least twice a day, and applying boric acid ointment. This, combined with careful dietetic and medicinal treatment, will generally be followed by favourable results.

Gouty deposits (*tophi*) are of very common occurrence in the auricle. They do not, as a rule, require any treatment.

A not uncommon disease occurs in the lobule from the irritation produced by piercing it for earrings. It consists in a fibroid growth, which partakes of the nature of keloid, and like it is very apt to return if removed. It is therefore best left alone, but if unsightly or showing a tendency to increase, it may be removed by taking a V-shaped piece out of the lobule, cutting wide of the disease, and suturing the cut surfaces together.

Diseases of the meatus.—Before proceeding to describe the diseases of the meatus, it is necessary to say a word or two on the method of examining this canal. The examination of the external meatus has for its object the ascertaining the condition of the lining membrane of the tube, the presence of any foreign body or accumulations of wax, and the state of the membrana tympani. It is carried out by throwing a strong light, by means of a reflector fixed to the forehead of the surgeon, down a funnel-shaped tube (a speculum), the end of which has been inserted into the orifice of the meatus. By this means, if the auricle is gently pulled upwards and backwards, so as to straighten the canal, the whole of the meatus and the membrana tympani can be seen, and any alteration in the size or calibre of the canal; or the presence or absence of any foreign body or cerumen; and the condition of the lining membrane and the membrana tympani, can be ascertained. In the healthy condition the membrana tympani presents a shining appearance, and on it the handle of the malleus can be detected running downwards and backwards, while a light streak can be seen running downwards and forwards. This streak is said to be due to a curvature of the membrane caused by the traction of the malleus, and is absent in those cases in which the membrane is thickened or opaque.

Accumulation of wax in the external meatus is of common occurrence, and leads to deafness and many unpleasant symptoms, as tinnitus aurium, giddiness, and even epileptiform seizures. The symptoms often come on suddenly; the wax has been gradually accumulating and, after a time, occludes the canal, it may be, from an alteration in its position or from an increase of size, owing to the admission of water and the swelling of the mass. As it collects, the wax becomes hard, and sometimes forms a complete cast of the tube. The condition can be at once diagnosed by means of the speculum.

The **treatment** consists in washing the wax out by means of a syringe. This, if properly applied, rarely fails to dislodge it, but warm olive oil or weak alkaline solutions dropped into the ear some hours before the syringe is used, materially assist its expulsion. The syringe should have a fine nozzle, and the stream of warm water should be directed along the roof of the meatus. It then finds its way behind the mass, and as it returns it brings away the hardened mass of wax. When the plug is expelled, the symptoms are at once relieved; but in some cases an irritable condition of the meatus, requiring soothing applications, remains. Occasionally a vegetable fungus, belonging to the species of aspergillus, may become located in the external meatus, and may be mistaken for an accumulation of wax, as it gives rise to the same symptoms—deafness, giddiness, and tinnitus. On examination the canal will present a black spotted appearance, and on syringing a membrane may be brought away, which on examination will be found to contain spores and mycelium.

The **treatment** consists in frequent syringing, and then filling the canal with an alcoholic solution of boracic or salicylic acid.

Inflammation of the external meatus (*Otitis externa*) arises principally from injury or from the injection of irritating solutions, but may also originate from other causes, as erysipelas, eczema, or may occur in the course of measles or scarlet fever in children. There is great swelling and redness of the cuticular lining of the canal, so that it becomes almost or completely closed. There is intense pain in the ear, aggravated by any movement of the jaw. There is at first a serous exudation, followed in the course of time by a purulent discharge, and this is usually attended with a mitigation of the symptoms. In severe cases the inflammation may terminate in perforation of the membrana tympani, or caries of the osseous walls of the canal. The prognosis is usually favourable, but the inflammation may assume a chronic form and give rise to otorrhœa.

The **treatment** consists in applying leeches to the ear, followed by hot fomentations. If the swelling and pain are excessive, an incision, under nitrous oxide gas, is indicated. When the acute symptoms have subsided a solution of nitrate of silver (gr. x to ℥j) should be applied with a camel-hair brush.

Boils are of common occurrence in the external meatus. They are due to the presence of micro-organisms, especially the staphylococci, in unhealthy constitutions. The symptoms are intense pain, often radiating over the head, and increased on moving the jaw. On examination, a circumscribed swelling will be found, which is exquisitely tender and sometimes almost blocks the canal. After a time the swelling bursts, with an immediate relief to the pain. Unfortunately, however, these boils are often recurrent and form one after another. In severe cases there is usually a certain amount of febrile disturbance and great exhaustion from the pain and want of sleep.

The **treatment** consists in giving the patient an anæsthetic—gas will generally suffice—and incising the boil with a fine knife. Hot fomentations should then be applied, and the ear constantly syringed with hot boric lotion.

Tumours.—**Sebaceous cysts** are occasionally found in the external meatus. Under an anæsthetic they may be incised and their contents turned out with a small spoon. **Polypi** are also common in the meatus, but they usually have their seat further inwards, and will be spoken of in the sequel. **Exostoses** are usually described as of two varieties: (1) the true exostosis, which is a single circumscribed bony tumour growing from the wall of the meatus; and (2) multiple enlargements of the canal, due to inflammatory periosteal formations. They are generally confined to one ear and are for the most part due to some local cause, as the repeated irritation produced by a chronic otorrhœa, or from constant bathing in salt water. They are, however, sometimes congenital, and are also said to be common in gouty subjects. When they completely block the canal they produce deafness; but this infirmity in these cases is more often due to retained secretion which cannot find an escape on account of the growth, and if this is removed periodically, the hearing is restored and no further treatment is advisable. But in those cases where the deafness is great, and especially where it is bilateral, or in those other cases where there is a perforation of the membrana tympani and the discharge cannot escape, it becomes necessary to remove the growth. This is best done by boring a hole through the base of the tumour by means of a drill and dental engine, and gradually, by increasing the size of the drill, grinding the growth away. The operation requires care and precision, but in the practised hand is not attended by much risk.

AFFECTIONS OF THE MIDDLE EAR

Method of examination.—For examining the membrana tympani or tympanum from the meatus, the speculum is used (see page 685). The points to be observed in examining the membrane are its opacity, its colour, and its vascularity; whether it is concave or bulging, and whether there is any perforation. When the membrane is completely or largely destroyed, the pink inner wall of the tympanum can be seen and possibly one or more of the ossicles. In examining the condition of the tympanic cavity and the Eustachian tube, the apparatus of Politzer is of great use. It consists of an india-rubber bag fitted with a blunt nozzle, and an india-rubber tube fitted with a nozzle at either end. One nozzle of the tube is inserted in the patient's ear, the other in the ear of the surgeon. The patient is instructed to take a small quantity of water into the mouth and retain it there until told to swallow. The nozzle of the india-rubber bag is placed in the nostril of the patient, and the nose is compressed between the finger and thumb, so as to close the anterior nares around the tube. The patient is now told to swallow, and at the moment of doing so the india-rubber bag is compressed. This fills the upper part of the pharynx with air, and as the Eustachian tubes are opened by the act of swallowing, the air rushes up into the cavity of the tympanum. If the Eustachian tube is pervious and the cavity of the tympanum healthy, the surgeon will hear the air impinge on the tympanic membrane with a sharp click; but if the Eustachian tube is occluded the sound will not be heard. In the event of the Eustachian tube being pervious and the cavity of the tympanum filled with fluid, a crackling, bubbling sound will be heard; and if the membrana tympani is perforated the air will be heard passing through the opening with a whistling sound. The patency of the Eustachian tube may be further tested by directing the patient to close the mouth and compress the nostrils with his finger and thumb; if he now makes a forced expiration he will be conscious of the air impinging against the tympanic membrane.

Furthermore, in examining a patient for deafness it is necessary to ascertain whether the conducting channels or the auditory apparatus are at fault, and this is to be done by the tuning fork. If a vibrating tuning fork is held firmly against the skull, and the vibrations are heard clearly, though the ear is deaf to vibrations conveyed through the meatus, it is clear that the conducting media are at fault and not the auditory apparatus. It is worthy of note that, in cases of unilateral deafness arising from some lesion in the conducting apparatus, the vibrations of the tuning fork are more distinct on the affected side. The degree of hearing through the air is usually estimated by the tick of a watch gradually approaching to the ear, and comparing it with the hearing of a healthy person.

Inflammation of the tympanum (*Otitis media*). Elaborate classifications of the different varieties of inflammation of the tympanum are sometimes given, but it will be sufficient in this work if we describe the acute and chronic form of the disease.

Acute inflammation of the tympanum may run on to suppuration or may not, and it is often customary, for clinical purposes, to differentiate between these two states and to classify them as (1) simple catarrhal inflammation, and (2) purulent inflammation. They arise, however, from the same causes, and the symptoms of the two are indistinguishable in the early stage. Anything which causes inflammation of the naso-pharyngeal mucous membrane, such as ordinary catarrh, scarlet fever, measles, or diphtheria, may set up acute inflammation of the middle ear. It is characterised by intense and agonising pain in the ear and over the side of the head. Noises in the ear and throbbing are complained of, and there is loss of hearing on the affected side. Accompanying these local signs there is usually a considerable amount of febrile excitement. In the simple catarrhal form the membrana tympani will be found to be reddened on examination, and sometimes bulging. In these latter cases rupture of the membrane may take place. When this occurs the symptoms are relieved, the perforation speedily heals, and there is no permanent loss of hearing. In the purulent form the symptoms are usually more acute and the febrile symptoms more severe. The external auditory meatus is frequently swollen and reddened; the membrana tympani opaque, acutely inflamed, and bulging. After a time the abscess bursts through the tympanic membrane, and the pain subsides. The perforation may close and recovery take place, but in many cases the disease becomes chronic, and otorrhœa is set up.

Treatment.—The patient should be confined to bed, and if the symptoms are at all acute or the pain severe, one or two leeches should be applied to the tragus, followed by hot fomentations. If there is any bulging of the membrana tympani, it should be punctured behind the handle of the malleus. If there is no pus the incision will do no harm, and the puncture will rapidly heal, while relief will be given to the pain by the evacuation of the mucus. If there is no bulging of the membrane, air should be blown into the tympanum by means of Politzer's bag, which will cause the mucus contained in the cavity to regurgitate with the air.

Chronic inflammation (*Chronic aural catarrh*).—This condition is almost always the result of repeated slight attacks of catarrhal inflammation, and rarely commences as a chronic affection. It is especially liable to occur in gouty, rheumatic, and syphilitic constitutions, and in many cases is distinctly hereditary. The first symptom which is noticed is a gradually increasing deafness, the difficulty in hearing often varying with the condition of the atmosphere, being worse in cold damp weather, and with the patient's health. In some instances patients can hear better in a noise, as when travelling or driving in a cab or omnibus. Tinnitus is usually present, and the patient complains that his ears feel as if they were occluded by some foreign body.

The **pathological** changes produced by the disease are numerous; among them may be mentioned thickening of the membrana tympani or the secondary membrane, and in some cases opacities and calcareous deposits; ankylosis of the ossicles, or of the stapes to the fenestra ovalis; thickening of the mucous membrane of the tympanum, and of the Eustachian tube, leading to its occlusion.

Treatment is never very satisfactory, and when the disease is thoroughly established it is apt to progress and lead to permanent deafness. The principal indications are to attend to the general health and treat any catarrh of the pharynx which may exist. In many cases improvement may be obtained by periodically inflating the tympanum with Politzer's bag, which helps to rid the cavity of any contained mucus. In those cases where the Eustachian tube is occluded, inflation by the Eustachian catheter is required. This instrument consists of a metal or vulcanite tube, about six inches in length, curved at one end and with a dilated funnel-shaped extremity at the other, into which the nozzle of an india-rubber bag can be fitted (fig. 263). To the funnel-shaped end a ring is attached in order to indicate the position of the point when the instrument is in the nose. In order to introduce the catheter into the Eustachian tube it is passed along the floor of the nostril, close to the septum, with the point touching the floor; that is to say, with the ring directed downwards, until it impinges on the posterior wall of the pharynx. It is then withdrawn slightly, so as to prevent the point from hitching in the mucous membrane, and rotated until the ring is directed outwards—away from the Eustachian tube which is being operated on. If the catheter is now pushed onwards, with a slight inclination of the point upwards, it will be felt to enter the tube and its point will be gripped. The india-rubber bag can now be adjusted to the atheter, and the ear inflated.

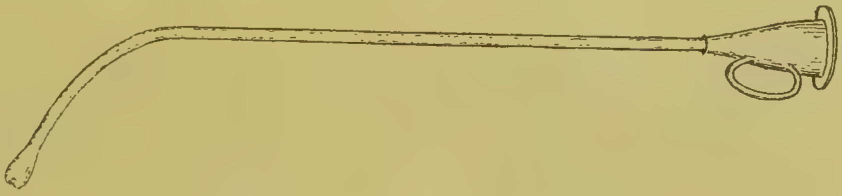

FIG. 263.—Eustachian catheter.

Otorrhœa simply means a discharge from the ear, and many causes nay give rise to this condition, such as eczema, or suppurating sebaceous ysts in the external canal, or ulceration of its lining membrane from foreign odies or other causes, or from caries or necrosis of the walls of the canal;

but by far the most common cause is suppuration within the tympanic cavity, with perforation of the membrana tympani. The discharge is often profuse and offensive, and the condition is always one of serious import, as it may be followed by many grave complications.

Treatment.—The ear must be kept carefully syringed once or twice a day, or even oftener, according to the amount of the discharge, with some warm dilute antiseptic solution; after which it must be carefully dried and insufflated with powdered boric acid or oxide of zinc and iodoform. Should this fail, weak astringent solutions, the salts of zinc or lead, may be tried. If any obstruction exists in the Eustachian tube, it must be relieved by Politzer's bag or the Eustachian catheter. After the discharge has ceased, if the perforation does not heal, great improvement to the hearing may often be obtained by the use of an artificial drum. The best form of this consists in a piece of moistened absorbent wool, which is passed down the canal with a fine pair of forceps until it reaches the remains of the membrane, when the patient will sometimes be at once conscious of an improvement in his hearing. Toynbee recommends the use of a thin disc of india-rubber fastened to a piece of silver wire, by which it is introduced, in place of the cotton wool.

Complications.—Various complications may arise during the course of chronic suppuration of the middle ear, some of which are of the gravest character: (1) polypus; (2) mastoid disease; (3) caries and necrosis; (4) meningitis; (5) extra-dural abscess; (6) cerebral abscess; (7) lateral sinus thrombosis, and pyæmia.

(1) **Polypus.**—The so-called *aural polypus* is a mass of granulation tissue springing from the tympanum in cases of chronic suppuration in that cavity and protruding through the perforated membrana tympani into the external meatus. It is usually firm and fleshy, but may be soft and gelatinous. The chief source of danger is that it may block up the meatus, and thus prevent the escape of pus.

Treatment.—The only treatment is removal, and this may be effected by a sharp curette or a wire snare. The former is the more convenient of the two, for the bare bone, which is exposed at its base, can be scraped at the same time. The part should be subsequently syringed with an antiseptic solution, and iodoform insufflated.

(2) **Mastoid disease** is an inflammatory condition of the walls of the mastoid antrum and cells, arising from a direct extension backwards from the tympanic cavity. The pus formed in the antrum and cells does not find a ready exit, and being retained in these cavities, decomposes and sets up inflammatory changes in the surrounding bony structures, which become gradually destroyed, and the pus reaches the surface and appears beneath the skin. In more chronic cases the antrum and cells are choked with lymph and inflammatory exudation of a cheesy character, while the bone becomes thickened and condensed.

The **symptoms** are deep-seated pain and tenderness behind the ear, the pain radiating over the side of the head. In the early stage, swelling and redness are not marked symptoms and may be absent, but later on redness and œdema appear over the mastoid process, and subsequently a fluctuating swelling may form. At the commencement of the attack the discharge from the ear often ceases, but commences again later on. The disease is accompanied by a very considerable amount of fever, and perhaps rigors. Vomiting is a frequent symptom, and other symptoms of cerebral irritation may be present, as giddiness, squint, tinnitus, &c.

Treatment.—In the early stage the patient should be confined to bed, and any discharge which may have collected in the tympanum got rid of by syringing and the use of Politzer's bag. Hot fomentations should be applied to the ear, and a brisk purgative given. In the event of relief not being afforded by these means, the surgeon should at once proceed to open up the antrum (fig. 264).

Operation.—The scalp in the neighbourhood having been shaved and rendered aseptic, an incision is made in a vertical direction a short distance behind the auricle, down to the tip of the mastoid process. The incision is carried down to the bone, and the soft parts are retracted. In some cases a perforation will be found in the bone, from which pus is exuding. When this is the case, all that is necessary is to enlarge the opening with a gouge. In those cases where there is no perforation, an opening must be made in the bone either with a gouge or small trephine. A line is drawn horizontally through the upper border of the bony external auditory meatus, corresponding with the posterior root of the zygoma. A second line is drawn vertically through the posterior wall of the meatus, and the bone is gouged in the angle where these two lines intersect each other (fig. 231). The gouge is directed downwards, inwards, and forwards, and the bone removed, in the adult, to the depth of about half an inch. The cavity of the antrum will then be reached, and will be recognised by the escape of fœtid pus and the loss of resistance. All granulation tissue and inspissated pus must be scraped away with a sharp spoon, and the remaining cells in the mastoid process opened up and cleared of their contents. The parts must be sluiced with antiseptic fluid and packed with gauze. Daily irrigation must be practised, and it will generally be found that the fluid injected into the sinus will return through the external auditory meatus. In severe cases a somewhat more extensive operation is advocated. It consists in separating the auricle from its bony attachment, and gouging away the whole of the bone which separates the antrum from the tympanic cavity, and then removing the ossicles and the remains of the membrana tympani. This operation is attended with the most satisfactory results, and if the large cavity thus formed is thoroughly cleared of all granulation tissue and septic material, rapid recovery takes place.

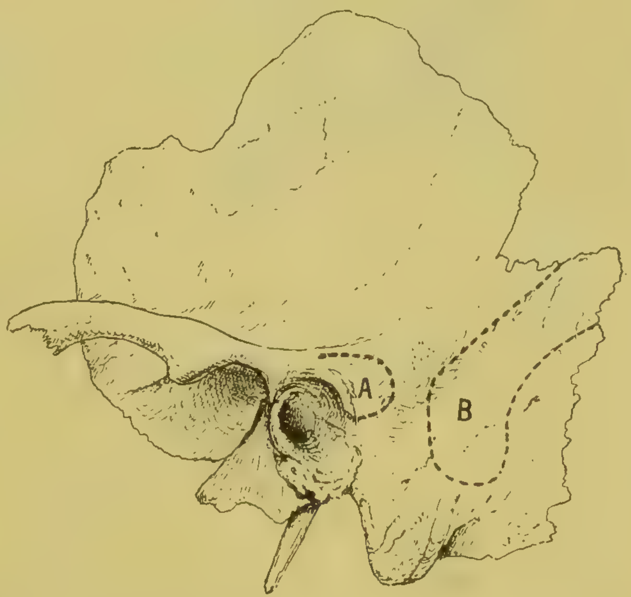

FIG. 264.—Diagram showing the position of the antrum and the lateral sinus. A, antrum ; B, lateral sinus.

(3) **Caries and necrosis** is another very common complication of chronic suppuration of the tympanum. Not only do the ossicles frequently become necrosed and separate, but almost any part of the temporal bone may be involved in the necrosis—the walls of the tympanic cavity, the

mastoid bone, the external meatus, and even the petrous bone containing the internal ear may die (fig. 265). When the disease is superficial, as in the meatus or mastoid process, the presence of the dead bone can usually be readily detected; but when the deeper parts, as the labyrinth, are the seat of the necrosis, the presence of the dead bone can only be inferred by the persistence of the discharge and the repeated formation of granulation tissue in polypoid masses, which resists all treatment. When the caries and necrosis can be detected, it may often be successfully treated by the removal of sequestra and the use of a sharp spoon, but every care must be taken, especially in dealing with the upper wall of the tympanum, as only a thin layer of bone separates it from the cranial cavity. In some cases where the bone becomes involved, the facial nerve as it lies in the aqueductus Fallopii may become implicated, and facial palsy result.

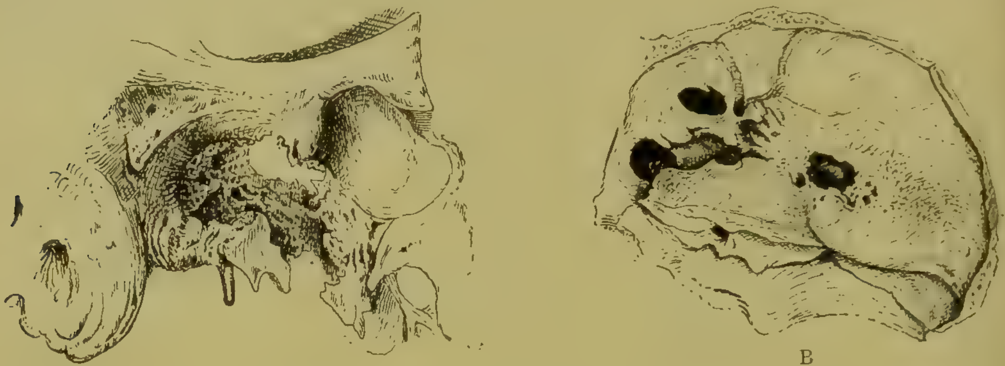

FIG. 265.—Preparation showing extensive disease of the bone in a case of otitis media purulenta. A, external surface; B, internal surface. (From the Museum of St. George's Hospital.)

(4) **Meningitis.**—Meningitis is an occasional sequence of chronic suppuration of the middle ear. It may be localised, and under these circumstances is not of very great importance, as it is merely the accompaniment of some other condition, and it speedily subsides if this condition is cured. More often it is diffuse, and is then generally septic in its nature, and is, as a rule, necessarily fatal. It is due to some suppurative condition of the mastoid antrum or to extra-dural abscess, or to thrombosis of the lateral sinus.

The **symptoms** are those of ordinary septic meningitis: intense headache with a high temperature, vomiting, intolerance of light and sound, and possibly a rigor at the onset; these signs being followed by delirium, twitching of the muscles, and finally coma and death (page 602). The treatment will have to be directed to the cause to which the meningitis is due, whether suppuration in the mastoid, or between the bone and the dura mater. The abscess must be freely opened, drained, and rendered as aseptic as possible.

(5) **Extra-dural abscess** is the result of the inflammatory process extending through the bone; exudation then takes place between the bone and the dura mater, which gradually becomes purulent. The most common situation for this to occur is on the anterior surface of the petrous bone, in the neighbourhood of the petro-squamosal suture. Here the bone separating the tympanum from the cranial cavity is extremely thin, and inflammation easily spreads through it and causes the formation

of matter between the bone and membranes of the brain. Another common situation for extra-dural abscess is in the groove in which the lateral sinus is lodged, in cases where the suppuration in the tympanum has extended to the mastoid cells. It is in these cases of extra-dural abscess that septic meningitis is liable to be set up, and under these circumstances the signs of the local abscess are obscured by the acuter symptoms of the meningitis. In those cases where the abscess is situated in the sigmoid fossa there is an additional risk of thrombosis of the lateral sinus.

The **symptoms** are by no means characteristic in the earlier stages of the disease. There is pain in the head, with a raised temperature, and possibly a rigor; after a time, as the effusion increases, symptoms of cerebral compression set in.

The **treatment** consists in evacuating the pus and draining the cavity. An incision is made as directed for opening the mastoid antrum, and a trephine of about an inch in diameter is applied so that the central pin perforates the skull half an inch above and behind the external auditory meatus. When the crown of bone has been removed, the anterior surface of the petrous bone can be explored at the upper part of the trephine hole by separating the dura mater from the bone, and the sigmoid portion of the lateral sinus at the lower and back part.

(6) **Cerebral abscess.**—Abscess in the cerebrum or cerebellum is a not uncommon complication of suppuration in the middle ear. The inflammation spreads through the bone to the membranes, and there sets up a septic thrombosis in one of the cerebral veins, which results in abscess. The most frequent situation for the abscess is the posterior part of the temporo-sphenoidal lobe, especially in children. In the adult a not uncommon situation is in the anterior part of the lateral lobe of the cerebellum, in those cases where the mastoid is involved in the ear disease. The symptoms in an uncomplicated case are well marked, but in most instances the signs are obscured by other complications, such as subdural abscess or meningitis, and then the diagnosis is difficult or almost impossible. In a typical case the symptoms come on insidiously, and are usually chronic in type. There is severe headache, vomiting, optic neuritis, and slow cerebration. If conjoined with these symptoms there is a slow pulse and subnormal temperature, the diagnosis of cerebral abscess may be confidently made. But in many cases, owing to the presence of meningitis or subdural suppuration, the temperature is above normal and the pulse increased in rapidity above the natural rate. Moreover, optic neuritis may be absent, and even if present does not necessarily prove that abscess exists, as it may occur in cases of meningitis or thrombosis of the lateral sinus. The student is referred to the chapter on Diseases of the Head (page 604) for a further description of abscess of the brain and also for the treatment.

(7) **Lateral sinus thrombosis** is the most formidable complication of middle ear trouble. It arises from an extension of the inflammation to the veins of the bone, which open into the sinus, or from extra-dural abscess in that part of the sinus which lies in the groove in the mastoid bone. The clot formed in the sinus is septic in character and rapidly extends into the internal jugular vein. By its disintegration it sets up secondary embolic abscesses in other parts, and a general condition of pyæmia.

Symptoms.—It is very desirable that the condition should be recognised early, because if prompt and energetic surgical treatment is applied before a general condition of pyæmia is set up, the results in many cases are of a most satisfactory character. The following are the important symptoms by which the disease may be recognised. There is the history of a purulent discharge from the ear, which in the majority of cases has existed for more than a year. There is a sudden onset, usually ushered in by a rigor, of severe pain behind the ear, general headache, and vomiting. Following this is local œdema over the mastoid, and deep-seated pain, greatly increased on percussion, along the course of the sinus. The vomiting is persistent and the rigors repeated, with an oscillating temperature. Later on there are tenderness and induration along the upper part of the internal jugular vein, stiffness of the muscles at the back and side of the neck, and in some cases optic neuritis. If the patient is not relieved by operation, evidences of pyæmia or meningitis manifest themselves and the patient dies.

Treatment.—In any case in which lateral sinus thrombosis is suspected, an exploration of the sinus should be at once made. This is done by trephining the skull at a point an inch behind the centre of the external auditory meatus and a quarter of an inch above Reid's base line (see fig. 231). When the crown of the bone has been removed, the outer wall of the sinus will be exposed. In many cases the mastoid antrum will probably have been previously opened and explored; under these circumstances, the sinus may be exposed by enlarging the opening which has already been made, backwards with a gouge. When the wall of the sinus has been exposed, if there is any doubt as to whether it is thrombosed or not, a small puncture should be made into it with a tenotome, and the escape of fluid blood will settle the question. There need be no fear of hæmorrhage in doing this, as the bleeding can always be arrested by pressure. If the sinus is found to be thrombosed, the surgeon should for the moment cover the trephine hole with a piece of gauze and at once proceed to ligature the internal jugular vein. This may be done by an incision along the anterior border of the sterno-mastoid, the centre of which is on a level with the great cornu of the hyoid bone. The vein should be ligatured in two places and divided between. Should the vein be found to be thrombosed at the point selected for the ligature, it must be traced downwards and tied at a lower level, below the thrombus if possible. After the internal jugular vein has been secured and divided, the surgeon returns to his trephine hole; if considered necessary, it may be enlarged with bone forceps or gouge, and the sinus laid freely open and all offensive clot cleared away as far as can be seen. If hæmorrhage should occur from the distal side, it can be at once stopped by careful plugging with iodoform gauze. The ligature is now to be removed from the upper end of the divided vein, and by syringing through from the lateral sinus the whole of the clot will be driven out of the vein. The ligature is now reapplied and the wound sutured. The wound in the sinus is plugged with gauze and dressed with a pad of wool and a bandage. In many of these cases where no secondary foci have developed in the lungs, the treatment is most satisfactory: the temperature falls at once to normal and all urgent symptoms disappear.

DISEASES OF THE INTERNAL EAR

The affections referred to the internal ear are very imperfectly known; their causes are not often discoverable, and for the most part they are beyond the skill of the surgeon. The symptoms produced by them are for the most part subjective, and they may be discussed under the three heads of (1) nerve deafness, (2) tinnitus, and (3) auditory vertigo, with which may be associated nausea and vomiting.

1. **Nerve deafness.**—Loss of hearing from involvement of the auditory nerve may be recognised from loss of hearing due to damage of the conducting media by the tuning fork (see page 688). It may arise (1) from general diseases of the system, of which syphilis, either acquired or congenital, is by far the most common; but it may follow on one of the exanthemata, or mumps, or from anæmia: (2) from intra-cranial mischief, such as aneurism of the basilar or auditory artery, or tumours, abscesses, or hæmorrhage: (3) from disease of the middle ear, generally by causing caries or necrosis of the labyrinth, but sometimes indirectly by causing reflex vaso-motor changes in this part: (4) from the long-continued use of certain drugs, such as quinine or salicin: (5) from sudden loud and unexpected noises, as the discharge of artillery.

The **treatment** depends in a great measure on the cause. In the syphilitic cases, antisyphilitic remedies; in the anæmic cases, preparations of iron, and so on, should be employed, but many of these cases are not amenable to treatment.

Menière's disease.—In connection with nerve deafness, allusion must be made to a peculiar disease, the essential lesion of which is believed to be seated in the semicircular canals. The leading symptoms are that the sufferer is suddenly attacked with giddiness, with an inclination to fall to one side, accompanied by nausea, retching, singing noises in the ear, sweating, and pallor. These symptoms pass off after a time, but leave the patient with a certain amount of deafness, which increases after each attack. In these cases there is always loss of power to hear sounds transmitted through the cranial bones in the affected ear. No treatment is of much use in this affection. Rest, counter irritation, quinine in large doses, and the bromides have all been recommended.

2. **Tinnitus,** or singing noises in the ear, may be continuous or intermittent. It arises from many causes, which may be general or local: among the former are anæmia, large doses of quinine or salicin; among the latter are plugs of wax in the meatus; or alteration in pressure in the labyrinth, which may arise from fluid in the tympanum and obstruction of the Eustachian tube. The treatment must necessarily depend upon its cause.

3. **Auditory vertigo** is characterised by a sudden attack which causes the patient to reel to one side or to fall either backwards or forwards. It is not as a rule accompanied by unconsciousness, but is frequently followed by nausea and vomiting. The attacks are paroxysmal, but patients liable to them often complain of constant giddiness. The condition is due to pressure in the labyrinth, or to intra-cranial lesions. The treatment must be directed to finding and removing the cause, if possible.

CHAPTER X

INJURIES AND DISEASES OF THE NECK

INJURIES OF THE NECK

Contusions of the neck require no special comment. They are usually of minor importance, unless complicated with some grave injury, such as fracture of the hyoid bone or laryngeal cartilages. They are to be treated by perfect rest, and all attempts to speak must be avoided. Cold in the shape of evaporating lotions or ice should be applied, and if there is any difficulty in swallowing, the patient should be fed by a tube passed into the stomach.

Wounds of the neck, with the exception of one class, which are popularly known under the name of *cut-throat*, also require no special description. They as a rule heal readily, and the only point in the treatment which requires particular comment is the necessity and difficulty that there is in keeping the parts in a condition of absolute rest. This is best done by the plaster of Paris corona, which has already been described in connection with the operation of removal of glands from the neck (page 380). The only special danger in connection with wounds of the neck, when they are inflicted in the lower part and a vein is wounded, is that air may be sucked in. This condition has already been described (page 282).

Cut-throat.—Wounds in the front of the neck, popularly termed *cut-throat*, may be either homicidal or suicidal. There is no means of distinguishing between the two, but it will generally be found that in the latter, if the suicide is a right-handed man, the wound will extend farther on the left side than the right, that it will present jagged edges, and will be directed obliquely downwards as it passes across the neck. This is due to the fact that when a man attempts to cut his throat with his right hand he begins well to the left, and as he draws the knife across the neck the hand becomes of necessity somewhat depressed, and so produces an oblique cut on the left side; by the time he reaches the middle line of the neck his determination fails him, and no doubt also, if the air passages are opened, the chest collapses and the muscles which pass from the chest to the upper extremity partially lose their support, and therefore the arm is unable to continue the effort, and the cut rarely extends far beyond the middle line. The wound is generally jagged, because the skin, not being tensed, rucks up under the knife.

Cut-throat wounds may vary much in depth; they may be quite superficial—mere scratches, in fact—when they are of little importance, or they may be deep, penetrating the air or food passages, or even extending down to the spine and notching the bone, or partially dividing an intervertebral disc. Suicidal wounds are rarely carried so deeply as to open the spinal canal and injure or divide the cord; but, of course, homicidal wounds may do so. Occasionally suicidal wounds may be punctured, made with the object of perforating some important vessel. The wound may be inflicted at any part of the neck, from the lower jaw to the top of the sternum; but by far the commonest situation is somewhere in the neighbourhood of the pomum Adami, either dividing the thyro-hyoid membrane or the upper part of the thyroid cartilage (fig. 266). When the wound is inflicted in this situation the main vessels of the neck generally escape injury, though the superior thyroid and lingual vessels may be divided. The head is thrown back to render the larynx prominent, and thus the vessels are guarded by the tension of the sterno-mastoid muscles.

Cut-throat wounds which do not extend into the air passages are much less dangerous than those which do. But nevertheless this class of wound is not always devoid of danger; for in addition to the risk that there is, when the wound is low down in the neck, of the admission of air into some severed vein, there is also the risk of very severe and fatal hæmorrhage, even though none of the large vessels of the neck have been wounded, from the venous plexuses or from the thyroid body, when it has been involved in the injury. A still more common source of danger is diffuse cellulitis of the neck, which is apt to be set up in these cases, and is especially dangerous because the suicide is generally a man of intemperate habits, has passed the middle period of life, and is often in a very despondent frame of mind, and therefore in a very unfavourable condition for repair.

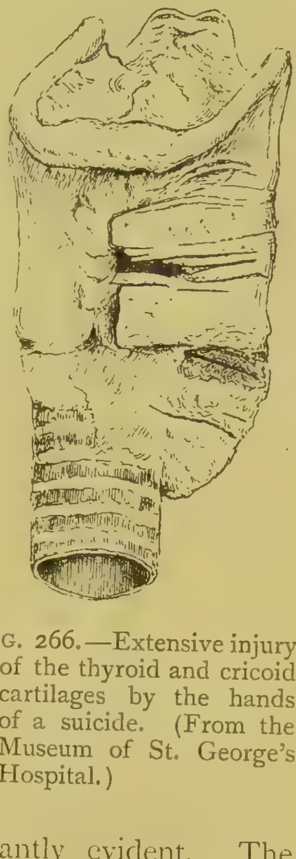

FIG. 266.—Extensive injury of the thyroid and cricoid cartilages by the hands of a suicide. (From the Museum of St. George's Hospital.)

In superficial wounds, after all hæmorrhage has been arrested, careful cleansing and disinfection should be carried out, and the wound should be accurately sutured and dressed antiseptically, care being taken to immobilise the neck as far as possible.

Cut-throat wounds which implicate the air passages may be at once diagnosed by the air being heard to bubble in and out of the wound during respiration, when the wound in the air passages is small. Generally it is of large size, and then the condition of things will be abundantly evident. The dangers which may arise from such a wound are several. (1) The patient may die of hæmorrhage, even when the large vessels of the neck are not injured, and this hæmorrhage may be either arterial, from the branches of the external carotid artery, particularly the superior thyroid, lingual and facial; or venous, from the large plexuses of veins in this situation. (2) Death may take place from asphyxia, and this in several ways: the blood may run down into the air passages and choke the patient; where the wound has been inflicted above the larynx, œdema of the glottis may supervene and prove fatal; or divided structures may be so displaced as to impede or obstruct respiration, as, for example, where the wound has been inflicted above the hyoid bone, dividing the muscles at the root of the tongue, this organ may fall backwards and choke the patient; or where the wound has been made through the thyro-hyoid space, the epiglottis may have been divided from its attachment to the thyroid cartilage, and hanging loosely by the aryteno-epiglottidean folds, it may be sucked over the glottis by an inspiratory effort and hermetically seal the rima glottidis; or, if the incision is still lower, a portion of one of the laryngeal cartilages may be cut off and may find an entrance into the air passages. (3) In these cases also, as well as in the more superficial wounds, diffuse cellulitis of the neck may be set up, and the matter formed may track down the neck into the chest, as far as the root of the lung. (4) Broncho-pneumonia is another very common danger in cases of cut-throat when the air passages are opened, and this may be set up in several different ways, from the direct admission of cold air to the lungs through the wound, without having been warmed by passing through the nasal cavities; by the inhalation of septic matter from the wound; and by the introduction of particles of food into the air passages in consequence of the loss of the natural sensibility of the glottis, which causes a collection of mucus in the bronchi which the patient is unable to expectorate, as a true cough is impossible where the opening in the air passages has been made below the glottis.

Subsequent complications which may arise after the patient has recovered from these more immediate dangers, are (1) dysphagia, which may be present from the first, where the food passages have been opened, or may subsequently arise in consequence of inflammation and resulting contraction interfering with the movements of the larynx during the act of swallowing. (2) The voice may be lost or modified, in consequence of inflammatory changes or from some nerve lesion. (3) The passages may become constricted during cicatrisation. (4) A fistulous opening into the air passages or gullet may remain permanently, or where the wound has been made high up, the submaxillary gland may have been injured and a salivary fistula result.

Treatment.—The first point to attend to in the treatment is to arrest all hæmorrhage. All bleeding points must be secured, and general oozing stopped by exposure to the air or pressure. Any portions of loose cartilage, and especially the epiglottis if it has been separated from its attachments, must be united with fine silk sutures. If the wound is lower down and the trachea is divided, the severed portions must be sutured on either side and a tracheotomy tube inserted.

Formerly it used to be the rule not to close the wound in the superficial structures except at the sides, but to leave the central part open, so as to prevent any accumulation of coagula or any burrowing of septic matter among the tissues of the neck; but if the wound can be rendered aseptic, the plan of uniting all the structures by successively suturing each layer with buried sutures should be resorted to. If this method is adopted, the best plan is first of all to perform tracheotomy, and insert a Hahn's tube, if the wound is in the usual situation in the thyro-hyal space; then the most careful cleansing and disinfection of the wound must be carried out, and the mucous membrane of the air tube must be carefully united with fine silk sutures which do not penetrate the whole thickness of the membrane; the muscles and fasciæ are united by another row of sutures, and finally the skin wound closed. It is a wise precaution in most cases to insert a drainage tube for the first twenty-four or forty-eight hours. If, however, the surgeon is not confident of being able to obtain complete asepsis, the wiser plan is to leave the centre of the wound open and simply approximate the cut edges by the position of the head of the patient, which should be bent forwards and fixed in this position by appropriate bandaging. The patient should be placed in a warm room, the air of which is moistened by steam, and the strength maintained by fluid nourishment. If the patient is unable or unwilling to swallow, he can best be fed by a small tube passed through the nose into the stomach. It need scarcely be added that he must be strictly watched, since these patients are very apt to make a further attempt on their life.

Contusions of the larynx are usually produced in attempts at strangulation. They may produce sudden death from spasm of the glottis or shock, but more commonly cause temporary insensibility, followed by great pain and swelling about the seat of injury, with partial or complete loss of voice, but often without difficulty in breathing. In some cases where blood has been extravasated into the submucous tissue there is urgent dyspnœa, accompanied, it may be, by cough and bloody expectoration.

The **treatment** consists in applying warm anodyne fomentations, and performing intubation or tracheotomy if the dyspnœa is urgent.

Fracture of the hyoid bone is of rare occurrence. It is usually caused by direct violence, as in hanging; forcible grasping of the throat in garrotting, or by a blow; but cases are also recorded where it has arisen from muscular action. The fracture generally occurs about the junction of the greater cornu with the body of the bone. There is great pain, increased by any attempt to swallow or speak, or upon turning the head. Upon examination some irregularity may be detected, and in rare instances crepitus may be felt, though this is not usual, as there is great displacement of the fragment. In some instances the broken end may perforate the mucous membrane, when there is constant tickling cough, accompanied by great pain and bloody expectoration, and sometimes dyspnœa.

Treatment.—The displaced fragment must be restored to its natural position by introducing one finger to the back of the mouth and manipulating it into place. A plaster of Paris collar, made of Bavarian flannel soaked in a solution of the plaster, should be adapted to the neck and over the back of the shoulders so as to support the head in the natural upright position. The patient should be kept absolutely quiet, and, if there is pain or difficulty in swallowing, should be fed for a few days with a nasal tube. If dyspnœa supervene, laryngotomy may be necessary.

Fracture of the cartilages of the larynx.—This injury is more common than fracture of the hyoid bone. One or more than one cartilage may be broken by the same act of violence, but the thyroid in the great majority of cases is either broken alone, or is fractured in conjunction with some other of the cartilages, more especially the cricoid (fig. 267). The injury is produced by direct violence, blows or falls on the part, or by forcible grasping by the hand of an adversary, or by strangulation. There is great swelling and bruising of the front of the neck, with pain, especially on swallowing or speaking, and more or less difficulty in breathing. On examination some alteration in the contour of the cartilages may be

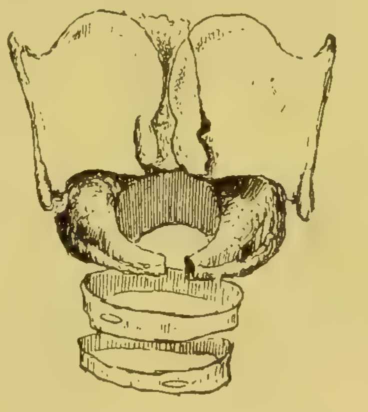

FIG. 267.—Extensive fracture of the thyroid and cricoid cartilages. From the body of a woman who was strangled. (From the Museum of St. George's Hospital.)

detected, and even a soft crepitation. In those cases where the fragments have perforated the mucous membrane, there is tickling cough, bloody expectoration, and often urgent dyspnœa.

Treatment.—In those cases where there is bloody expectoration, proving that the mucous membrane has been lacerated, and any considerable amount of dyspnœa, it is always safer to perform laryngotomy at once, or, at all events, to be prepared to do it at a moment's notice. Where there is no dyspnœa, it is sufficient to keep the patient at perfect rest, after the displacement has been rectified as far as possible by manipulation. An attempt may be made to keep the fragments in apposition by carefully adjusted pads of wool or lint and a bandage.

Complete rupture of the trachea.—Although this injury is rare, cases have been recorded. It is generally produced by severe blows, but in a case recently occurring in St. George's Hospital, it was caused by a blow from a lift on the back of the head, as the patient was looking down a shaft; in this case there was also a fracture of the sternum. The symptoms produced are urgent dyspnœa and great subcutaneous emphysema, and the cases, as a rule, rapidly prove fatal. A low tracheotomy should be immediately performed.

Scalds of the pharynx and glottis are usually caused among the children of the poor by the child attempting to drink boiling water from a kettle. The water does not find its way into the larynx, as it is prevented by spasm of the glottis, but it scalds the pharynx and gives rise to inflammation and œdema of the glottis, which may speedily cause death from suffocation. The child suffers from attacks of spasmodic dyspnœa, the voice is hoarse and the respiration croupy, it is unable to take food, and an examination of the mouth shows it to be covered with white patches (see page 645). The case speedily terminates fatally unless relieved.

Treatment.—In the first instance an effort should be made to subdue the inflammation by the application of leeches to the neck, followed by hot fomentations and the administration of wine of antimony (♏j to ij) with tincture of aconite (♏ $\frac{1}{4}$ to $\frac{1}{2}$) every quarter of a hour for an hour or two, until some effect is produced, and then at longer intervals. The child should be put in a steam tent or breathe a warm moist atmosphere. If the breathing still continues laboured, scarification of the mucous membrane of the back of the fauces and upper part of the larynx should be resorted to, and often affords manifest relief. If, however, these measures fail, tracheotomy must at once be resorted to, or intubation should be performed (see page 708). In spite of this, the cases frequently terminate fatally from tracheitis or broncho-pneumonia.

Foreign bodies in the air passages.—Any foreign matter, gaseous, fluid, or solid, may enter the air passages, but the only ones we are concerned with in the present place are solid foreign bodies. These are always carried into the air passages by inhalation; that is to say, some foreign substance is lodged in the mouth, and as it is carried to the back part of the cavity in the act of swallowing, a sudden inspiration is taken, and the foreign body is sucked with the air into the air passages, or else is lodged in the rima glottidis, mechanically obstructing it.

For purposes of clearness it is desirable to divide these foreign bodies into two classes: (1) those which are large and cannot pass through the rima, and these are generally soft, like a piece of meat; and (2) those which are so small that they can pass through the rima glottidis, and these are often hard, such as a piece of bone, a pebble, a button, or a cherry- or plum-stone.

(1) When a large soft body, like a piece of meat, is carried towards the air passages by a sudden inhalation, it becomes wedged in the upper cavity of the larynx, and each effort at inspiration only tends to wedge it more tightly (fig. 268). When this occurs, all access of air to the lungs is cut off. There is a sudden feeling of intense suffocation; the patient makes violent efforts at inspiration, becomes black in the face, falls insensible, and dies almost immediately, unless assistance is at once rendered.

The **treatment** in these cases is to at once force the mouth open and attempt to dislodge the foreign body with the forefinger, and, failing this, to perform laryngotomy with a penknife. This can only be done should the surgeon chance to be present at the time of the occurrence; if not, the patient will in all probability be dead before his arrival.

(2) If the foreign body is small enough to pass through the rima glottidis, it may be fixed in one of the ventricles of the larynx; or it may pass into the trachea; or it may descend through the trachea and become lodged in either of the bronchi or their ramifications, and the after symptoms will vary according to the position in which it is placed. But in all, the primary symptoms will be the same, and will be those of obstruction; the subsequent symptoms being due to irritation and inflammation set up by the presence of the foreign body.

Symptoms. — The primary symptoms are those of obstruction, due to spasm of the glottis. The foreign body in passing through the highly sensitive glottis irritates it, and induces a reflex spasm of the muscles of the larynx, which effectually closes the chink and prevents the admission of air. The patient starts up wildly, gasping for breath; the face becomes livid and covered with a cold sweat, and he becomes more or less insensible. Now innervation is arrested, the spasmodic contraction of the muscles passes off and the patient takes an inspiration, generally accompanied by a croupy sound, and the symptoms of obstruction disappear. The foreign body has now passed onwards, and the symptoms to which it gives rise, and which are now due to irritation, will depend upon its situation, size, and nature.

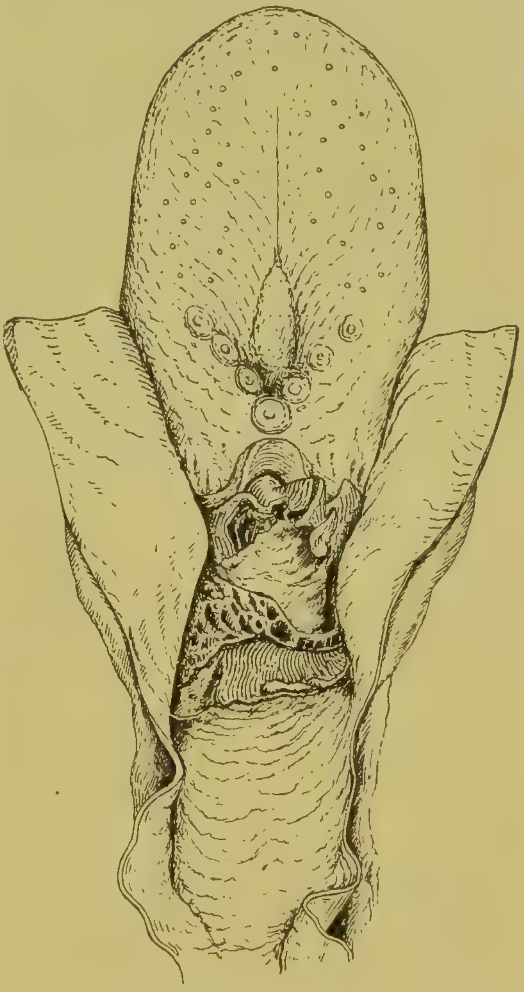

FIG. 268.—A lump of meat impacted in the glottis, and producing death from suffocation. (From the Museum of St. George's Hospital.)

1. When the foreign body is lodged in one of the ventricles of the larynx, the symptoms will depend much upon its nature. When it is sharp and angular and projects from the ventricle into the cavity of the larynx, irritating the vocal cords, there is great distress and a constant sense of suffocation, accompanied by spasmodic cough and a croupy respiration. The voice is hoarse or altogether lost. When, however, the foreign body is smaller and buried in the ventricle, none of these signs are present except the alteration in the voice. The diagnosis will then be mainly based on the history of the case, that the child while it had something in its mouth was attacked with a sudden fit of suffocation, and on the absence of any inflammatory condition about the throat which could give rise to the hoarseness. In addition to this the foreign body may sometimes be felt by the finger introduced into the mouth or seen with the laryngoscope; and if the foreign body is a metallic one or a piece of bone, it may be demonstrated by the Röntgen rays.

The **treatment** in these cases consists in performing laryngotomy, and then dislodging the foreign body by some blunt instrument introduced through the wound and pushing it back into the mouth, except in those cases where the foreign body can be felt with the finger introduced into the mouth, when it can probably be extracted with forceps. In the event of the foreign body being so fixed that it cannot be dislodged, the laryngotomy must be converted into a thyrotomy (page 708).

2. When the foreign body has passed into the trachea, the symptoms will vary according to the size and weight of the substance. If it is small and of no great weight, it floats about in the trachea, moving upwards and downwards with respiration; if, on the other hand, it is large and heavy, it sinks to the lower part of the trachea and remains there; or, if smaller, finds its way into one of the bronchi. When it remains loose in the trachea, moving about with respiration, it must necessarily occasionally come in contact with the lining membrane of the tube, when it sets up a violent fit of coughing. During this expiratory effort the foreign body may be driven against the glottis and excite spasm, so that the patient becomes black in the face, makes violent attempts at inspiration, and presents other signs of obstruction; this is succeeded by a croupy inspiration, and the patient is relieved for a time. The attack is succeeded by another and another. In addition to this, the foreign body may be heard, with the stethoscope, moving up and down and striking the wall of the trachea. If the foreign body is large and heavy and sinks to the lower part of the trachea, where it remains, there will be evidence of more or less obstruction to the entrance of air and sibilant râles during inspiration.

The **treatment** in these cases consists in performing tracheotomy, and making a good free opening in the trachea. The foreign body is very often expelled through the wound by coughing at the time of the operation. If not, the edges of the incision in the trachea should be sutured to the skin wound, and in a large majority of cases, where the foreign body is movable, it will be spontaneously expelled. If it is fixed in the lower part of the trachea, the treatment must be the same as that pursued when it is lodged in one of the bronchi, and will be considered immediately.

3. When the foreign body has found its way into one of the bronchi, it is usually believed that it more frequently finds its way into the right bronchus, because it is larger and because the septum between the bronchi lies somewhat to the left of the middle line; but there is considerable difference of opinion on this point, and the statistics of different collectors

of cases appear to vary. The symptoms produced depend upon whether the bronchus is entirely occluded or not. If it is, no air can enter the lung, and the normal vesicular murmur is entirely absent, and all vocal fremitus is lost, while the respiration on the opposite side is exaggerated. The percussion note varies; at first it is normal, or in some cases there may be hyper-resonance, but in a short time the lung becomes congested and then there is diminished resonance, and sometimes complete dullness over the whole of the chest. Where the bronchus is not completely obstructed (fig. 269), the respiratory murmur is diminished but not abolished, and a whistling noise may sometimes be heard over the region of the bifurcation of the trachea, from the passage of air through a narrowed chink between the foreign body and the wall of the tube. In many cases, no doubt, skiagraphy will, in future, prove useful in determining the presence and position of a foreign body.

Treatment in these cases consists in performing a low tracheotomy and stitching the edges of the wound in the trachea to the skin wound. If the foreign body is not expelled spontaneously in a day or two, the trachea and bronchi should be carefully explored with a long probe; this may excite a violent fit of coughing, during which the foreign body may be expelled; or the patient may be inverted and at the same time sharply struck on the back over the region of the bifurcation. This may dislodge the foreign body. Failing this, the surgeon should attempt by delicate forceps, a hooked probe or loop of wire, to extract it. This is often a matter of extreme difficulty, the introduction of the instrument causing violent coughing, and the surgeon is baffled in all his efforts.

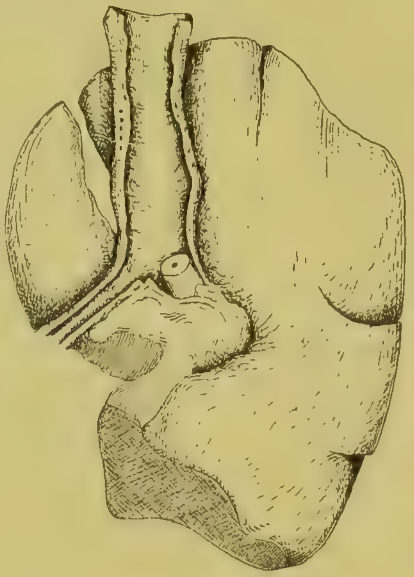

Fig. 269.—A piece of the stem of a clay tobacco pipe impacted in the right bronchus. Respiratory sounds could be heard over the whole of the right lung, though they were somewhat deficient. (From the Museum of St. George's Hospital.)

In those cases where the presence of the foreign body is overlooked, or where it cannot be removed, sooner or later inflammation is apt to be set up. A cavity is formed around the foreign body in the substance of the lung. This is accompanied by purulent and bloody expectoration. The patient becomes hectic and develops symptoms resembling phthisis, and gradually dies in a few months of exhaustion; or an extensive broncho-pneumonia may be set up and carry off the patient more rapidly. Occasionally, after abscess has formed and the foreign body has become loosened, it may be coughed up and the patient recover.

Tracheotomy.—When the air passages require opening, the operation of tracheotomy is the one usually resorted to; laryngotomy being, as a rule, reserved for cases where the air passages require opening in an emergency for the relief of some sudden obstruction to respiration. In addition to those cases where the operation may be required for the removal of foreign bodies from the trachea or bronchi, tracheotomy is required for a considerable variety of conditions: as diphtheria and other forms of laryngitis; for tumours, either within the air passages or pressing upon them from the outside; for stenosis; and for paralysis of the muscles of the larynx, especially bilateral paralysis of the abductors. It is also performed as a preliminary measure in some operations about the mouth or throat to prevent the entrance of blood into the air passages, or secondary septic pneumonia. Two operations are usually described: (1) the *high* operation, performed above the isthmus of the thyroid body, which usually crosses the third and fourth rings of the trachea; and (2) the *low* operation, in which the trachea is opened below the isthmus; but as a matter of practical experience, it would seem immaterial whether the isthmus is divided or not, and the trachea may be opened either above, below, or behind it. As a general rule, however, it may be laid down that, except for the extraction of foreign bodies, the trachea should be opened as high as possible, as the higher the opening is made, the easier it is to perform and the less the risk attending the operation.

The **high operation** is performed as follows: the patient should be laid on his back in a good light, with a pillow under his shoulders, so as to throw the head back, and this should be held by an assistant in a straight line with the body. Chloroform may be administered in most cases for the preliminary incision, or the part may be rendered locally anæsthetic by cocaine or ethyl chloride. An incision of an inch and a half or two inches in length is made in the middle line of the neck, commencing at the upper border of the cricoid cartilage. After the superficial structures have been divided, the interval between the sterno-hyoid muscles must be found, the raphé divided, and the muscles separated and drawn asunder with blunt hooks. The lower border of the cricoid cartilage must now be felt for, and the upper part of the trachea exposed by using the handle of the scalpel.[1] The isthmus of the thyroid body may be seen and may be dragged downwards, or it may be disregarded. The trachea may now be steadied by a sharp hook made to transfix it, as recommended by some, but this is not really necessary; if the cricoid cartilage is simply held with the finger and thumb, the tube can be easily opened by driving the point of the knife into it at the lower part of the wound and dividing the two or three exposed rings from below upwards. That the trachea has been opened is at once known by the rush of air, generally followed almost immediately by a violent fit of coughing, and often, in membranous laryngitis, by the expulsion of membrane. The tracheotomy tube is then to be inserted. Sometimes difficulty is experienced in doing this; if, however, the bivalve cannula is used, this difficulty is generally obviated—the two sides of the outer cannula are compressed between the finger and thumb, so as to form a wedge-shaped body, which can be easily made to glide through the incision; if other forms of cannulæ are used, a pair of dressing forceps introduced through the opening can readily be made to dilate it and the tube introduced on a pilot. The tube is tied in by tapes passed through the openings in the shield and secured behind the back of the neck. The second tube is then inserted within the first, and a layer or two of gauze packed between the shield and the skin around the wound to prevent excoriation.

Many forms of tracheotomy tubes are described and recommended, but the surgeon will as a rule be sufficiently equipped if he is provided with two or three bivalve tracheotomy tubes and the same number of Durham's tubes in different sizes, and to these he should add a few of Morant Baker's india-rubber tubes. The bivalve tracheotomy tube (fig. 270, B) is certainly the most convenient, as far as concerns its introduction into the trachea at the time of the operation, but otherwise it is not a good form of tube, and it is not desirable that it should be allowed to remain in the trachea for a longer period than a couple of days at the outside. On account of its shape, the end is very liable to press against the wall of the trachea and produce ulceration; so that if it is employed at the time of the operation, it should always be removed on the second day and a Durham's tube substituted. Durham's tracheotomy tube (fig. 270, A) is on the whole one of the best forms: on account of its shape, it lies in the trachea without pressing on

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[1] In my case of tracheotomy instruments I have the ends of the handles of the scalpels shaped like a spear head, so as to facilitate this.

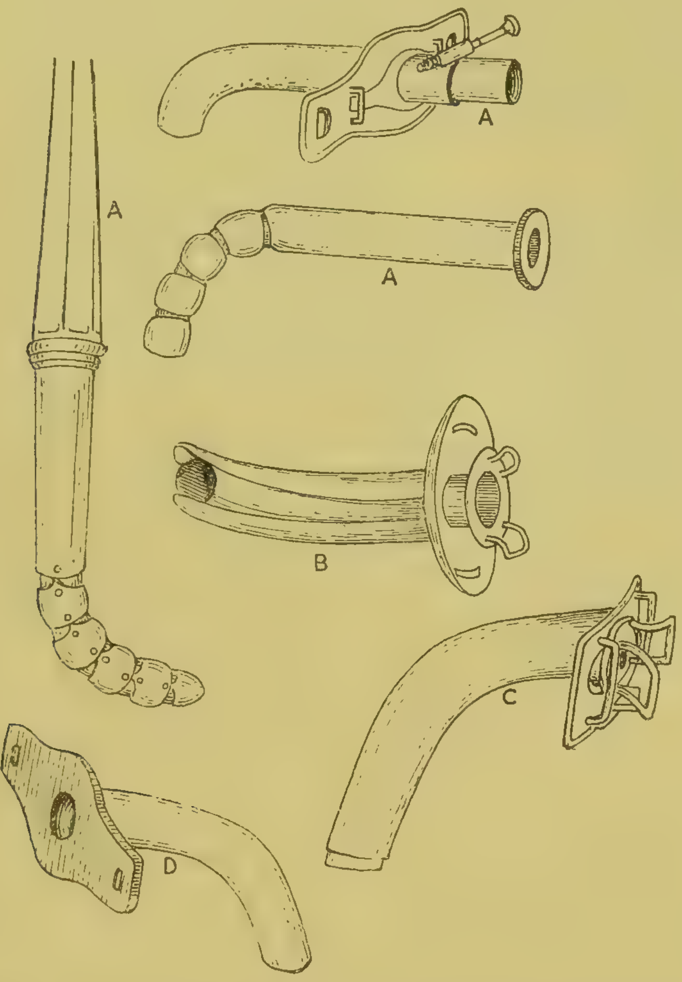

FIG. 270.—Tracheotomy tubes. A, Durham's tube, with pilot. B, bivalve tube. C, Parker's tube. D, Morant Baker's india-rubber tube.

its walls, and the shield can be placed at any part of the tube, so as to djust it to the depth of the trachea. Another form of tube which also orresponds with the natural direction of the trachea and which does not roduce irritation is Parker's angular tube (fig. 270, C). Morant Baker's ndia-rubber tube (fig. 270, D) is especially useful in those cases where he instrument has to be worn for some considerable period of time. It as sufficient rigidity to prevent its collapsing, but not sufficient to give rise o any irritation, and is altogether much more comfortable to the patient. oreover, the silver tubes if worn for a considerable time are liable to become oxidised and eroded, and sometimes detached from the shield, when they slip down the trachea.

In those cases where the tracheotomy is performed for the purpose of preventing blood getting into the trachea during an operation about the mouth or throat, the outer tube is surrounded with compressed sponge, which has been rendered aseptic by being soaked in a solution of iodoform in ether (Hahn's cannula). The sponge when moist swells considerably and completely blocks the trachea. The anæsthetic is administered by means of an india-rubber tube which is connected with the inner cannula, to the other end of which a funnel, containing a piece of lint or sponge, is fixed: on this the chloroform is dropped. Another form of instrument which may be used for the same purpose is Trendelenburg's tampon cannula. Here the outer tube is covered with a thin layer of india-rubber, which can be inflated by means of a syringe after the tube has been introduced into the trachea.

Low operation.—The trachea requires opening below the isthmus of the thyroid body in cases of foreign bodies in the windpipe or bronchi. The operation is performed much in the same way as in the high operation, but the incision is begun below the cricoid cartilage and carried down almost, but not quite, to the episternal notch. After the superficial structures have been divided, the sterno-hyoid and sterno-thyroid muscles must be drawn aside, and care observed not to wound the inferior thyroid plexus of veins. It must be borne in mind that the left innominate vein as it crosses the trachea often lies above the level of the episternal notch, and therefore the deeper structures should not be divided at a lower level than an inch above the sternum. In infants the thymus gland also ascends for a variable distance into the neck and may be exposed in the operation. When the trachea is exposed, it is to be opened in the manner described for the high operation. This latter operation is altogether more difficult, and is attended with a greater amount of danger, than the operation above the isthmus.

Difficulties of the operation. — When tracheotomy can be done deliberately on an adult with a thin neck, the operation is one of comparative ease; but usually the proceeding has to be undertaken on a child with perhaps a fat neck, hurriedly, often with insufficient light and assistance, and then it becomes surrounded with difficulties. The principal difficulties which may be encountered are:

1. Hæmorrhage. This sometimes is slight, but in other cases where there is intense vascular engorgement it may be very free and prove embarrassing to the young operator. It is not often arterial; when it is, it arises chiefly from wounding some anomalous branch, and the vessel should at once be caught with a pair of artery clips. When the bleeding is venous and comes from any vein of considerable size, and is profuse, which is not often the case, the bleeding must be arrested by artery clips before the trachea is opened; but when the bleeding is rather a uniform oozing from vascular engorgement, it is usually better to disregard it and to proceed to open the trachea as rapidly as possible, when it will immediately cease as soon as the respiration is established. The surgeon need never be afraid of the hæmorrhage in tracheotomy, if only he has got sufficient room by making a free enough incision, unless indeed he should unfortunately wound the left innominate vein in the low operation.

2. There may be difficulty in finding the trachea in a young and fat child. This will generally arise from want of attention to detail: either

the child's head has not been thrown sufficiently back, or the external incision is not free enough, or has not been made in the middle line. If these points are attended to there ought to be no difficulty in finding the trachea, except in those cases where it has been pushed to one side of the neck by a growth on the other.

3. A greater difficulty sometimes arises in opening the trachea after it has been exposed, and it is on this account that many surgeons recommend the introduction of a sharp hook into the trachea to steady it before opening it. It has always seemed to me to be quite as difficult to introduce the hook as to incise the trachea, and I have generally found that by fixing the parts with the finger and thumb in the manner described, there is no difficulty in opening the trachea after it has been thoroughly exposed. In addition to this, it has appeared to me that by fixing the trachea and drawing it up, there is more danger of pushing the knife through the tube and wounding the œsophagus.

4. Another difficulty is making too small an opening in the trachea. When the point of the knife is introduced, if it is not carried fairly into the tube it is apt to slip out again as it is carried upwards, and thus instead of a free opening dividing two or three rings being made, only a small puncture exists. When this has taken place it will be indicated by a slight hissing sound at the moment of the puncture, and by the absence of any relief to the dyspnœa. Under these circumstances the opening must be enlarged by a second introduction of the knife.

5. Finally there may be difficulty in introducing the tube. In the first instance, unless care be taken, the surgeon is apt to push the tube down between the trachea and the deep fascia of the neck instead of into the wound; and again, if a bivalve tube be used, and the operator is not careful to keep the two blades in contact, he may push one into the opening and the other by the side of the trachea. If only he will take care to keep the two blades in contact and feel with the top of his forefinger for the opening, there ought never to be much difficulty in introducing this form of tube.

Laryngotomy.—The operation of laryngotomy has sometimes to be performed at a moment's notice in cases of urgent dyspnœa. It may be done by plunging a penknife transversely into the crico-thyroid space, and by means of a piece of wire, or a hairpin twisted into the form of a hook, pulling the edges of the wound apart. A toothpick may then be inserted as a temporary tube through which the patient may breathe. When it can be done as a more deliberate operation, a vertical incision is made in the middle line, over the crico-thyroid space, of about an inch in length. This will expose the crico-thyroid membrane, which is then divided transversely close to the upper border of the cricoid cartilage, so as to avoid wounding the crico-thyroid artery, which usually lies in the upper part of the space. A tube is now inserted and the operation completed. In children the crico-thyroid space is so small that the operation of laryngotomy cannot be performed so as to admit of a sufficiently sized tube, and some surgeons have recommended that in these cases a laryngo-tracheotomy should be performed, that is to say, that the crico-thyroid membrane and the cricoid cartilage should be divided. The operation has now, however, fallen into abeyance, and is not to be recommended, as it interferes with the integrity of the larynx. A high tracheotomy ought therefore always to be performed in children.

After treatment of tracheotomy and laryngotomy.—When an operation, in which the air passages have been opened, has been performed, the patient should be kept in a well-warmed room, the air of which should be kept moist by means of one of the different forms of bronchitis kettles, and care should be taken that he is not exposed to any draughts. The tube must be kept clean by frequently removing the inner one, and washing it in a solution of bicarbonate of soda (gr. xx to ℥i) in order to remove any dried mucus which may be clinging to its interior. A nurse should be in constant attendance to wipe away mucus or false membrane (in membranous laryngitis) which may be expelled. She should be provided with some feathers to pass down the tube in order to clear it. In cases where the secretion is viscid, and rapidly dries and clings about the tube, spraying the cannula occasionally with the bicarbonate of soda solution will be found useful. The patient must have plenty of fluid nourishment. There is often some difficulty in getting the patient to take this, on account of the pain and difficulty in swallowing, and it is sometimes necessary in children to pass a soft red rubber catheter through the nose into the stomach in order to feed them.

The tube should be removed as soon as possible. It is often difficult to know when it is safe to do this. A cannula with an opening on its upper surface should be inserted, and when the patient can breathe freely with a cork inserted into the entrance of the tube, it is generally safe to remove it.

Thyrotomy.—This operation consists in vertically dividing the thyroid cartilage in the median line, and pulling the alæ of the cartilage apart so as to thoroughly expose the interior of the larynx. The operation may be required for the extraction of foreign bodies in the ventricle of the larynx, which cannot be dislodged by other means (see page 702); and for the removal of tumours of the larynx; it has also been done in cases of laryngeal phthisis in order to completely scrape away the tuberculous material. If possible, the operation should be preceded by tracheotomy some days previously, and at the time of the operation a Hahn's cannula should be inserted into the trachea. An incision is made in the middle line of the neck from the hyoid bone to the cricoid cartilage, and the thyroid cartilage divided with a knife, or fine saw if ossified, exactly in the middle line, so that the attachments of the vocal cords may be interfered with as little as possible. The crico-thyroid membrane is then to be nicked on either side, and the two alæ of the thyroid cartilage drawn asunder with blunt hooks, and the interior of the larynx exposed. The foreign body can now be extracted, or the tumour removed, or the tuberculous ulcer scraped. The wound is then closed, the two halves of the cartilage being first carefully and accurately sutured with chromic gut. Great care must be observed in doing this, so that the vocal cords are exactly on the same plane; in spite of this, however, the operation is usually attended with alteration in the voice sounds, and is never, in consequence, lightly to be undertaken.

Intubation of the larynx.—Recently attempts have been made by the introduction of a tube between the vocal cords to relieve laryngeal obstruction without having recourse to the operations of tracheotomy or laryngotomy. The subject has been thoroughly worked out by O'Dwyer, who has devised a tube which is oval in shape, and has an expanded upper end which rests on the ventricular bands after the tube has been passed between the vocal cords. These tubes are made in various sizes for patients of different ages, and supplied with them is an *introducer*, by which the tube can be placed in position, and an *extractor*, by which it can be removed. Intubation is especially adapted for laryngeal obstruction which is acute, as in œdema of the larynx and scalded throat; it is not so applicable to cases of membranous laryngitis, when the trachea is filled with membrane. It has, however, been successfully used in cases of stenosis, after tracheotomy or ulceration of the larynx. It requires considerable skill and practice to accomplish quickly; the tube is liable to be expelled by coughing at any time, and the proceeding is not devoid of certain special risks, such as extensive ulceration and even necrosis of the cartilages, falling of the tube into the trachea or swallowing of the tube. The tube is often now left in position for three, four, or five days, but another inconvenience which follows its use is the difficulty which the child experiences in swallowing its food. In quite young children the act of deglutition is accomplished most easily when the child is made to lie on its back, with the head in a dependent position.

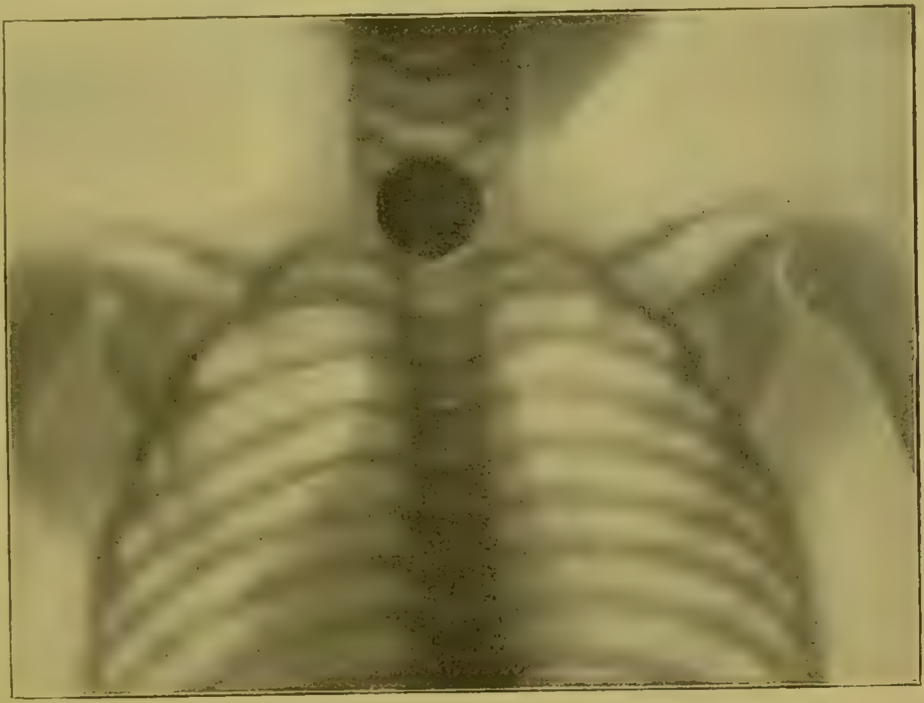

FIG. 271.—Skiagraph of a halfpenny in the œsophagus.

Foreign bodies in the œsophagus.—Foreign bodies not infrequently become lodged in the œsophagus, especially in children. The most common are coins, pieces of bone, fish bones, plates of false teeth, and pins. In the majority of cases, when any hard substance is swallowed, it passes down the œsophagus into the stomach, and is then got rid of through the intestinal canal. Frequently patients will come saying that they have swallowed a foreign body, and they can feel it sticking in the œsophagus. The sensation is produced by some slight scratching or injury to the mucous membrane, the foreign body having passed downwards into the stomach; but in some cases it may be lodged in the œsophagus, and is then generally impacted about the level of the cricoid cartilage just beyond the reach of the finger, though it may become fixed at a much lower level, just above the cardiac orifice of the stomach. Frequently where the body is smooth, and especially in the case of coins, it may give rise at first to very few symptoms, and therefore these cases should not be lightly regarded, but it is always safer to examine first with the finger, and if nothing can be felt, a probang should be passed. Even when this is done the foreign body may elude detection, and in many instances skiagraphy steps in and renders important aid in diagnosis. Fig. 271 is a skiagraph of a little boy who swallowed a halfpenny, which became impacted in the œsophagus, where it remained five days, eluding detection until a skiagraph was taken, which revealed its presence. The early recognition of a foreign body impacted in the œsophagus is of importance, since sooner or later the mucous membrane swells and the muscular coat yields, and thus the foreign body becomes inclosed in a pouch-like dilatation from which it is impossible to dislodge it. Frequently it also causes ulceration; matter forms which may burst into the pleural cavity, or pneumonia may be set up and cause the child's death.

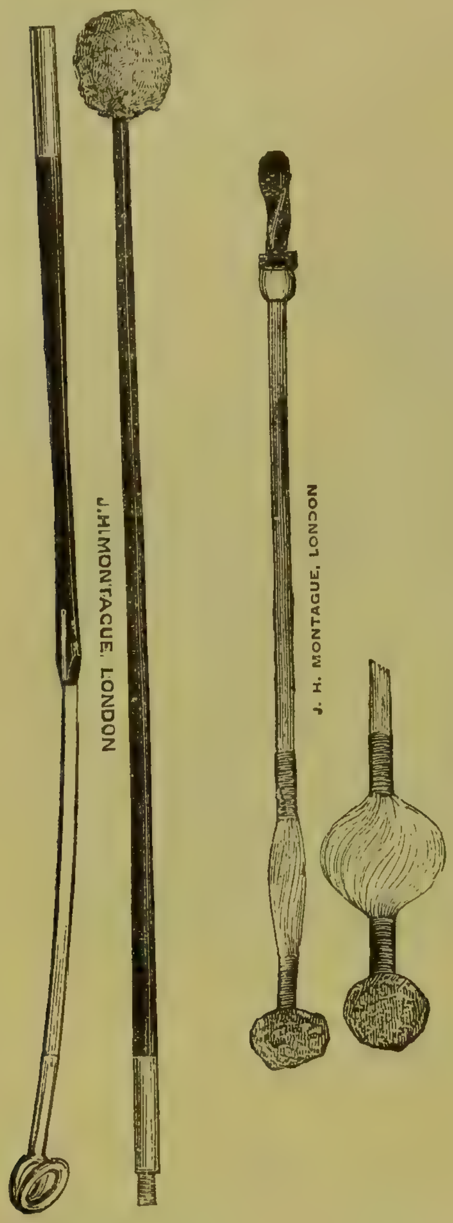

FIG. 272.—Probang with expanding bristles, and coin-catcher, for removing foreign bodies from the œsophagus.

Treatment.—The treatment must depend in a great measure on the situation and nature of the foreign body. If it is a coin, the 'coin-catcher' (fig. 272) will be found a most useful instrument for its extraction, and the same instrument may often be usefully employed in extracting a plate of false teeth. When the foreign body is small, as a fish bone or pin, it is best removed with an expanding probang. Œsophagus forceps are principally useful in removing foreign bodies, such as pieces of bone or plates of false teeth, from the upper part of the œsophagus; they can seldom be successfully used where the foreign body is situated lower down. Where the impacted body is soft, as a bolus of food, it may be gently pushed down into the stomach, but this plan should never be adopted where the foreign body is hard and irregular. Where these measures are unsuccessful and the foreign body is situated in the upper part of the œsophagus, œsophagotomy should be performed, and the operation should be done as soon as all other measures have proved futile. If done early it is not a particularly dangerous proceeding, but if left until ulceration and suppuration have taken place the risks are materially increased.

Œsophagotomy.—The patient's neck having been previously rendered aseptic, the head is extended and turned to the right side, and an incision is made from a little above the level of the upper border of the thyroid cartilage to the sterno-clavicular joint a little in front of the anterior border of the sterno-mastoid muscle. The skin, platysma and deep fascia having been divided, the common carotid artery is exposed, crossed by the omo-hyoid muscle. This muscle should be divided between two ligatures, and the sterno-mastoid muscle and the vessels pulled outwards by blunt retractors, and the larynx inwards. This will expose the thyroid body, and the position of the inferior thyroid artery passing upwards and inwards to the lower border of the lateral lobe of this body should be borne in mind; also the position of the recurrent laryngeal nerve running upwards between the trachea and the œsophagus. By a little manipulation with a director the œsophagus can now be exposed, sometimes projecting over the foreign body. If there is any difficulty in distinguishing it, a probang should be passed down the mouth, which will serve as a guide to its situation. The tube is now to be opened by a clean cut on the foreign body or probang, as far back as possible to avoid the fibres of the recurrent laryngeal nerve, and the opening enlarged, if necessary, with blunt-pointed scissors. Great care should be taken not to bruise the edges of the wound in the œsophagus, and no attempt should be made to dilate it by stretching, as it may interfere with union. The foreign body is now seized with sequestrum forceps and extracted. If large, as a plate for false teeth, it may be advisable to cut it across and extract the halves separately, care being taken that neither half slips down into the stomach. If the foreign body has only been impacted for a short time and there is no evidence of ulceration of the mucous coat, and the wound in the gullet has not been bruised, it may be sutured with chromic gut, the sutures not being allowed to penetrate the mucous coat, and the external wound closed; but if the coats of the œsophagus are ulcerated or if they are inflamed, the wound should be left open, drained, and a hot moist antiseptic dressing applied. After the operation a soft india-rubber tube should be passed through the nose into the stomach, and by this means the patient should be fed for some days. The great danger of the operation is septicæmia, from the wound becoming sloughy and foul. When the foreign body is lodged in the lower part of the œsophagus and cannot be extracted or pushed into the stomach, it will be necessary to perform gastrotomy, and by inserting a finger through the opening, finding and dilating the cardiac orifice, and extracting the foreign body with long sequestrum forceps.

DISEASES OF THE NECK

Cellulitis.—Acute diffuse cellular inflammation of the neck is of common occurrence after scarlet fever or septic wounds in this situation. The tissue involved is generally that beneath the deep fascia, and there is great danger of the inflammation spreading downwards into the thorax. There is rapid swelling of the neck, with brawny induration and redness of the skin; the swelling after a time becoming soft and fluctuating. In many cases serious pressure on the air passages or the great vessels of the neck may result.

The **treatment** consists in making incisions through the deep fascia, preferably in the middle line or along the anterior border of the sterno-mastoid, and opening up the cellular tissue in every direction. Hot boric fomentations should then be applied.

Acute abscess of the neck may be diffused or circumscribed. It is usually set up by inflammation of the lymphatic glands. The course which the pus will take depends upon its position with regard to the cervical fascia. In many cases it has burst into the trachea or œsophagus, and even into the pleura, and in some instances the great vessels of the neck have been opened up. This, no doubt, is on account of the tough character of the cervical fascia, which prevents the escape of the matter through it and causes it to burrow laterally and destroy the tissues with which it comes in contact. Acute abscesses in the neck should therefore be opened early; indeed, in these cases, it is wiser to incise the hard, brawny swelling at once, without waiting for any evidence of fluctuation, and take means to prevent the closing of the incision by inserting a drainage tube.

Angina of Ludwig is a form of cellulitis of the connective tissue beneath the deep cervical fascia in the submaxillary region, which comes on without any apparent reason, but which is no doubt due to a specific poison. It commences with a brawny induration in the submaxillary region, with great constitutional disturbance, and generally a rigor. It tends to spread into the mouth, pushing the tongue upwards and backwards, and interfering with respiration and deglutition. It also tends to spread downwards into the neck, and dangerous symptoms are often produced by pressure on important vessels and nerves; or it may spread inwards to the glottis, producing œdema, which may cause the death of the patient from suffocation. It runs a rapid course, is accompanied by extreme depression, and usually terminates fatally in a few days from septic intoxication. If the patient survive longer, extensive sloughing and suppuration ensue, and the matter burrows in every direction.

Treatment.—A free incision must be made at once into the brawny tissues, and these must be thoroughly opened up. Good drainage must be provided, and hot antiseptic fomentations applied. The patient's strength must be supported by plenty of fluid nourishment, and stimulants and quinine given in large doses.

Chronic abscess of the neck is of common occurrence, and is usually the result of the caseation and breaking down of tuberculous glands. It has already been alluded to (page 379).

Tumours of the neck.—Many varieties of tumour are found in the neck, of which perhaps the cystic form the most important group, the solid tumours possessing few features out of the common, and requiring therefore merely a passing allusion.

Among the **solid** tumours of the neck, the *lipoma* is perhaps more common than any other. One form of this, the *diffuse lipoma*, has already been alluded to (page 235) as occurring frequently at the back of the neck or in the submaxillary region; but occasionally, especially in young subjects, a circumscribed lipoma may occur at the root of the neck, immediately above the clavicle, and I have seen such a case mistaken for a hernia of the lung in this situation. Another form of solid tumour which is occasionally met with in the neck is the *osteoma*; an exostosis growing from the transverse process of one of the cervical vertebræ. This may easily be mistaken for a supernumerary rib, and may cause serious symptoms by pressing on one of the cords of the brachial plexus or on the subclavian vessels. *Nævi* are not uncommon in the neck, and *papillomata* and other tumours of the skin are sometimes met with, often in connection with the branchial clefts. By far the most common form of enlargement met with in the neck are the glandular tumours; these may be associated with tuberculosis or syphilis, or be secondary to a malignant affection in the neighbourhood, or a primary sarcoma of the glands of the neck may be found. The neck is also a common situation for lymphoma and lymphadenoma. Finally, solid tumours are sometimes developed in the substance of the sterno-mastoid muscle. These may be either gummatous or what has been termed the *congenital tumour of the sterno-mastoid*, but which is really an inflammatory induration, the result of some injury to the muscle during delivery, generally in a breech presentation (see Torticollis).

In addition to this general enumeration of the solid tumours which occur in the neck, tumours of the thyroid body and parotid gland must also be mentioned. These will be considered later on with the diseases of these parts.

Cystic tumours of the neck.—The varieties of cysts met with in the neck are several, and some of these require special mention. They are as follows:

1. **Cystic hygroma.**—The cystic hygromata have already been described (page 231). They occur in other situations than the neck, though this is probably the place where they are most commonly found. They are apparently situated in the subcutaneous tissue, but very frequently are connected with the deeper parts by processes which render their removal impossible. They form tumours of irregular outline and may sometimes attain a very considerable bulk, and produce great deformity or serious symptoms from pressure on important parts. They often undergo in the process of time diminution in size, apparently as the result of attacks of spontaneous inflammation.

Treatment.—Attempts have sometimes been made to remove them, and if they are small and have apparently no deep attachments such attempts are justifiable. In the majority of cases, however, the wiser course to pursue is to tap and inject iodine, in the hope that a gradual diminution may take place.

2. **Unilocular cyst.** (*Hydrocele of the neck.*)—These tumours are often congenital. Their origin is uncertain: they have been supposed by some to be due to a collection of fluid in an imperfectly closed branchial cleft; by others, to dilatation of some of the lymph spaces. They are usually situated in the posterior triangle, and consist of a very thin-walled cyst containing a serous fluid. They form smooth, firm, tense tumours, which sometimes feel almost solid. The treatment consists in tapping and injecting iodine.

3. **Blood cysts** (*hæmatocele of the neck*) are of two kinds: (1) where an effusion of blood takes place into a hydrocele of the neck. This is usually the result of tapping; the support of the contained fluid having been removed, the vessels of the wall of the cyst give way and blood is effused into the cavity. (2) The second is a very rare condition. It consists of a thin-walled cyst, containing pure blood, and is believed to originate from a dilatation of one of the large veins in the neck. In some cases they can be partially emptied by pressure, showing that the communication with the vein still exists. Under these circumstances the vessel with which they communicate must be ligatured above and below the opening, and the cyst may then be dissected out. When the communication has been cut off, they may be tapped and injected with perchloride of iron.

4. **Dermoid cysts.**—Dermoid cysts may be found in the neck, either in the middle line or in the situation of one of the branchial clefts. The

most common situation is in the middle line of the submaxillary region under the tongue (see page 653). Cysts may also form in the thyro-glossal duct, which remains unobliterated in part, and a collection of fluid takes place in this patent portion. The dermoid cysts are lined by stratified epithelium, and contain a mucoid or glairy fluid, in which is fatty matter and epithelium. They rarely contain hairs.

5. **Bursal cysts** are usually situated in the middle line in connection with the larynx. One over the pomum Adami may be sometimes enlarged, and it is said by some that another exists between the back of the hyoid bone and the top of the thyroid cartilage, which may become enlarged. Occasionally bursal cysts develop by the side of the larynx. They may be excised if they give rise to any inconvenience.

6. **Hydatid cysts** do not often occur in this region.

7. **Malignant cysts** are sometimes found in the neck. They may be primary, when they are supposed to originate in the epithelium of a portion of included epiblast; or secondary, in consequence of a cystic degeneration of an epitheliomatous gland. They are of rapid growth, and usually appear in advanced life. They attain a large size and speedily destroy life. Their removal is not practicable.

Congenital branchial fistulæ.—These fistulæ arise from the imperfect closure of the branchial clefts. They are often hereditary, and frequently several members of the same family may possess them. As a rule they cause little inconvenience. A small opening is visible, most frequently along the anterior border of the sterno-mastoid, which is often concealed by a little reduplication of the skin containing a nodule of cartilage. This opening admits a fine probe, which can be passed upwards for a considerable distance in the direction of the pharynx and sometimes can be passed into this cavity. A little viscid discharge occasionally oozes from the orifice. They are more often situated on the right side of the neck, though in some individuals both sides are affected. Attempts to cure them have not been followed by any great measure of success, and as they cause little inconvenience they are better left alone.

The thyro-glossal duct may in like manner remain pervious, constituting a median cervical fistula. The fistulous track may extend upwards between the genio-hyo-glossi muscles to the foramen cæcum of the tongue. These fistulæ are better left alone, as any attempt to excise them or incise them and destroy their epithelial lining is generally unsuccessful.

DISEASES OF THE PHARYNX

Pouching of the pharynx. (*Pharyngocele.*)—The name *pharyngocele* has been given to a peculiar pouch-like dilatation of the lower part of the pharynx, which is occasionally met with. The pouch consists of a hernial protrusion of the walls of the pharynx just above its termination in the œsophagus. Its walls, when the sac has attained any size, consist only of the mucous and fibrous coats, but when small the muscular coat also may be found to form part of its walls. The sac projects downwards between the œsophagus and the vertebral column, and is always more prominent on the left side (fig. 273). The cause of this condition is not known, but it is believed that it is congenital, owing to some defective development: at first being small it produces no definite symptoms, and it is not until it has acquired some size that any inconvenience arises from it, for it is a well-ascertained fact that no indications of the condition present themselves until the patient has, at all events, attained adult life.

The **symptoms** are very marked. There is dysphagia, the patient complaining that when he attempts to swallow, the food appears to be arrested at a certain point in the gullet, and that after a time it is regurgitated in an undigested condition. In this respect it resembles stricture, but there is in addition to this the appearance of a swelling on the left side of the neck when the patient takes food, which can generally be both felt and seen. This swelling can be made to disappear on pressure, the food in it sometimes being forced backwards into the mouth; at other times, especially if the pressure is gently applied, passing down the œsophagus into the stomach. Where the pouch has attained a large size, serious symptoms may be produced by pressure on the air passages or the great vessels and nerves of the neck.

Treatment.—Until recently these cases have appeared to be beyond the reach of surgery; but within the last few years a radical cure has been obtained by removing the diverticulum. An incision is made along the anterior border of the sterno-mastoid on the left side of the neck; the pouch is exposed and freed from its connections and then cut off at its neck. The opening thus left in the pharynx is then accurately sutured and the external wound closed, a large drainage tube being left at its most dependent part, in case any leakage should take place from the wound in the pharynx. The results of the operation have been most encouraging.

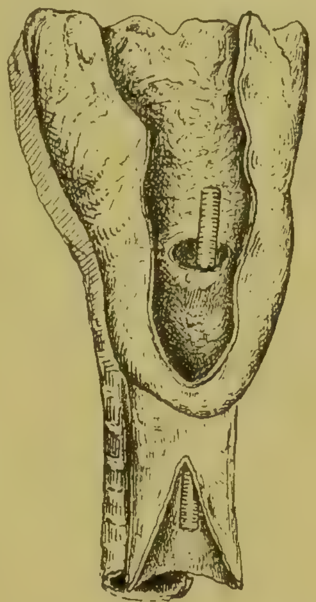
Fig. 273.—Pouch in the pharynx. (From the Museum of St. George's Hospital.)

Simple acute pharyngitis, or ordinary sore throat, is usually of a catarrhal nature, due to 'catching cold.' It is usually associated with a similar catarrhal condition of the nasal mucous membrane, tonsils and soft palate. It may also owe its origin to the exanthemata. The symptoms are pain and a sensation of dryness about the throat and fauces, accompanied by irritable cough and sneezing. The pain is much increased on attempting to swallow. Upon examination the mucous membrane of the throat looks swollen and red, and covered with a muco-purulent secretion. The **treatment** consists in confinement to bed, the inhalation of steam, and some medicine (e.g. pulv. ipecac. co.) to produce a profuse diaphoresis.

Phlegmonous pharyngitis.—This is a far more dangerous, but happily a rare, condition. It generally arises from injury, but may occasionally be set up without assignable cause, some authorities believing that it is due to the invasion of the streptococcus of erysipelas, while others are of opinion that it is caused by a poison of a virulent character, which is entirely distinct from erysipelas. It is attended with rapid infiltration of the submucous tissue, which often spreads early to the glottis, causing dyspnœa and death from œdema glottidis. The **symptoms** are in the early stage very similar to those of the simple form, swelling, redness, and pain in swallowing, but they are accompanied by severe constitutional disturbance and high fever, and soon deglutition becomes impossible and breathing laboured and difficult. The disease usually terminates in death, and upon post-mortem examination the mucous and submucous tissues are found infiltrated with purulent fluid and sometimes gangrenous.

Treatment.—The fauces and wall of the pharynx, as far as it can be reached, should be well scarified, and the patient should inhale steam and be kept in a hot moist atmosphere. If the breathing becomes difficult, laryngotomy or intubation should be performed. As much fluid nourishment and stimulants as can be taken should be given.

Erysipelatous pharyngitis.—A very similar condition to the foregoing may be set up by the extension of erysipelas from the face. The condition does not, however, appear to be so uniformly fatal. The chief danger to apprehend is œdema of the glottis, and the effects of this must be averted by a timely laryngotomy. Painting the throat with strong solution of perchloride of iron is often beneficial, and the patient should inhale steam and his strength be supported by plenty of fluid nourishment and stimulants.

Chronic pharyngitis may be the sequel of an acute attack or repeated acute attacks of pharyngitis, or it may commence as a chronic condition, especially in smokers and individuals who drink raw spirits. It also arises from errors of diet, especially in the gouty. The condition is attended by a vascular condition of the mucous membrane of the pharynx, which will be seen to be red and covered by enlarged vessels, which course across it. The surface is usually covered with a quantity of thick greenish tenacious mucus, which clings to the wall of the pharynx and can only be dislodged by constant hawking. The disease is accompanied by a feeling of discomfort and irritation of the throat, with constant cough, pain in swallowing and alteration in the voice sounds, which become husky, nasal, and finally lost, the patient being only able to speak in a husky whisper. The breath is sometimes offensive, from the decomposition of the mucus, which becomes dry and clings to the walls of the pharynx in the form of scabs. Two forms of this condition are usually described.

1. **Chronic follicular pharyngitis** occurs principally in individuals who make excessive use of the voice, and hence is popularly known as *clergyman's sore throat.* It is characterised by marked enlargement of the mucous follicles of the pharynx, and this condition often extends to the mucous membrane of the opening of the glottis, and is accompanied by redness and swelling of the larynx, and especially the vocal cords, as visible by the laryngoscope. The mucous membrane is seen to be dotted by little rounded elevations, which occasionally coalesce into streaks.

2. **Chronic atrophic pharyngitis** (*pharyngitis sicca*) is a chronic condition which is often associated with repeated attacks of catarrh. The mucous membrane becomes thin and smooth, and the exudation forms thin scabs. The throat feels abnormally dry, and there is huskiness of the voice.

The **treatment** of chronic pharyngitis is often tedious and unsatisfactory. In the first place, every endeavour must be made to ascertain the cause, and this must if possible be removed. The throat should be sponged with astringent lotions, or inhalations of fir-wood oil employed. The general health must be attended to, and improved by tonics and change of air to a warm, dry atmosphere when possible. In the follicular form of the disease the greatest benefit is derived from destroying the enlarged follicles with the galvano-cautery, or by touching them with a bead of chromic acid fused on to the end of a probe. In the dry form the inhalation of chloride of ammonium is usually beneficial, or chloride of ammonium lozenges may be sucked.

Retro-pharyngeal abscess is due to suppuration in the loose connective tissue which lies between the back of the pharynx and the bodies of the cervical vertebræ. It may be acute or chronic.

1. **Acute retro-pharyngeal abscess.**—There would appear to be two ways in which acute abscess may be set up: (1) from an acute inflammation in the lymphatic glands, which are situated in this region, originating in some affection of the pharynx or naso-pharynx. This is probably the most common cause, and almost invariably occurs in young children; (2) acute retro-pharyngeal abscess may be caused by some abrasion of the mucous membrane of the pharynx, and the admission of pyogenic organisms to the retro-pharyngeal connective tissue.

Symptoms.—The symptoms come on somewhat abruptly; the patient, if a child, refuses its food, and if it attempts to swallow, the fluid regurgitates through the nose. The temperature is raised, and there is swelling and pain on palpation about the upper part of the neck, and probably some of the lymphatic glands in this situation will be felt to be enlarged. There is difficulty in breathing, with possibly stridor, and after a time the child becomes cyanosed and may die of asphyxia if not relieved. On examining through the mouth, a smooth elastic swelling will be seen and felt bulging into the pharynx.

Treatment.—Incision of the abscess is at once called for. This may sometimes be done by an opening in the neck, when the abscess can be felt bulging in this situation; but in the acute form of abscess in young children, an opening through the mouth is generally the only course which can be pursued. The child's head should be thrown well back, the mouth opened with a gag and the swelling freely incised with a sharp-pointed bistoury, properly guarded. This is usually followed by immediate relief to the symptoms.

2. **Chronic retro-pharyngeal abscess** is generally the result of cervical caries, though it may also arise from disease of the bones at the base of the skull.

Symptoms.—The condition comes on insidiously. A child, who is suffering from tuberculous disease of the cervical vertebræ and presents the characteristic rigidity of that disease, will be noticed to swallow with difficulty; the voice will become altered, and there will be marked snoring at night. Upon examination of the pharynx, a tense, elastic swelling will be found behind the posterior pharyngeal wall, bulging it forwards. The abscess, if left to itself, may burst and discharge into the pharynx, when it forms a fistulous opening communicating with the diseased bone (fig. 274), or it may point at the side of the neck, behind the sterno-mastoid muscle, being guided to this situation by the prævertebral fascia, behind which it is situated; or in rare instances it may travel downwards, beneath the prævertebral fascia, into the posterior mediastinum, or pass outwards into the axilla. As in other tuberculous abscesses, there is no elevation of the temperature, nor pain.

Treatment.—In these cases, for antiseptic reasons, the abscess should be opened from the neck. In some instances this is perfectly easy: the abscess can be felt bulging in this situation and merely requires an incision; but this is not always so, and then an incision about an inch and a half in length should be made along the posterior border of the sterno-mastoid, and the deep cervical fascia divided. A director is now to be inserted into the wound, the forefinger of the left hand being introduced into the mouth and pressure made upon the swelling. This acts as a guide, and the director is to be pushed onwards until pus appears in the groove. A pair of sinus forceps are now inserted along the director, and the opening in the abscess cavity dilated. As much of the caseous material as possible should be scraped away with a blunt spoon, and the cavity irrigated and drained. The whole proceeding must be conducted antiseptically, and some fixation apparatus applied to the cervical spine.

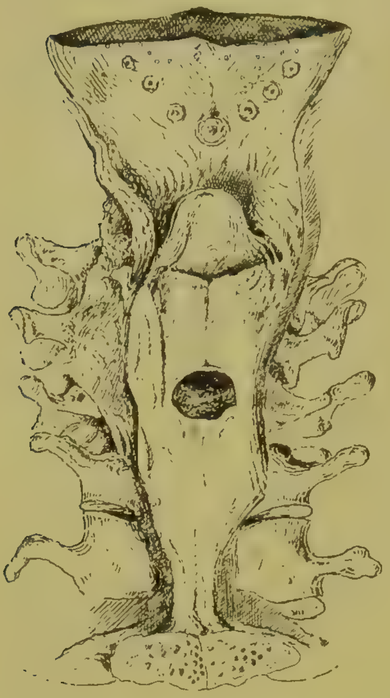
FIG. 274.—Retro-pharyngeal abscess, opening into the pharynx. (From the Museum of St. George's Hospital.)

Retro-pharyngeal gumma.—Gummatous tumours sometimes form in the connective tissue at the back of the pharynx, and may be mistaken for retro-pharyngeal abscesses, but the absence of any signs of cervical caries ought to be sufficient to enable the surgeon to distinguish these cases.

Tumours of the pharynx.—Some forms of innocent tumours are occasionally met with in the pharynx, as fibromata and papillomata. Of these the latter are the more common, and may generally be removed by snipping them off with blunt-pointed curved scissors, or by means of the galvano-cautery.

Naso-pharyngeal polypi have already been described (page 632).

Malignant tumours are more common, and may be either carcinomatous or sarcomatous. The squamous epithelioma is the form which is most frequently met with, and may be either primary or secondary to disease of adjacent parts, the tonsil or the tongue. It is attended with intense pain on swallowing, with a constant hawking up of foul, bloody discharge, rapid emaciation and speedy implication of the glands in the neck. Death generally occurs from hæmorrhage, from implication of some large vessel, or from exhaustion from starvation induced by inability to swallow. Sarcoma is not nearly so common, nor is it attended with the same amount of pain in swallowing. The condition is one rather of difficulty in swallowing, than of pain excited by the act.

Quite recently attempts have been made to deal with these growths by operation, and certainly while the disease is confined to the pharyngeal wall the operation is perfectly justifiable, though hitherto it has not been attended with a large measure of success. The operation is best performed by means of a free incision along the anterior border of the sterno-mastoid. The external carotid artery is first ligatured, and then the pharynx opened and the growth excised: any enlarged glands must be removed through the same incision.

Formerly it was proposed to remove tumours of the pharynx by *sub-hyoid pharyngotomy.* This consisted in making a transverse incision immediately below the hyoid bone, cutting through the thyro-hyoid membrane, and detaching the epiglottis from the back of the tongue.

DISEASES OF THE ŒSOPHAGUS

Malformations of the œsophagus are not common. They may consist either in a congenital communication between the œsophagus and trachea, or in a complete closure of the upper part of the gullet, the lower part communicating with the trachea. As these conditions are incompatible with life, it is scarcely necessary to enter further into their description.

Diverticula of the œsophagus.—In addition to the pouches which have been already described (page 714), and which are usually rather in the lower part of the pharynx than the œsophagus, though they are sometimes described as springing from this part of the alimentary canal, small pouches are occasionally found, on post-mortem examination, in the œsophagus, generally about the level of the bifurcation of the trachea. They are supposed to arise from inflammatory conditions in the tissues outside the tube, which by the subsequent contraction of the cicatrix resulting from the inflammatory process, drag out the wall of the œsophagus and cause a little funnel-shaped pouch. They are matters of little importance, except that a foreign body might become lodged in them, and being retained set up inflammation.

Inflammation of the œsophagus, accompanied or not by ulceration, is usually caused by the swallowing of caustic fluids, or in a localised form by the impaction of a foreign body, but it may also occur in an acute form as an extension of the inflammation from pharyngitis above or gastritis below. It is accompanied by intense pain on making any attempt to swallow, so much so that the patient avoids even swallowing his own saliva and refuses food. This is accompanied by great tenderness along the course of the œsophagus in the neck and brawny swelling of the tissues outside. There is constant hawking up of glairy mucus and sometimes pus.

A **chronic form** of inflammation of the œsophagus is sometimes found in spirit drinkers, accompanied by enlargement of the mucous glands and hypertrophy of the mucous coat. This may sometimes lead to stricture.

The **symptoms** are pain and difficulty in swallowing, with a dull aching sensation along the course of the œsophagus.

The **treatment** consists in giving complete rest to the part by rectal feeding and administering morphia by hypodermic injection.

Stricture of the œsophagus.—There are three varieties of stricture of the œsophagus: 1. spasmodic stricture; 2. fibrous stricture; 3. malignant stricture. They all give rise, as their most prominent symptom, to dysphagia, but it must not be forgotten that this sign may arise from many other causes besides stricture, and in investigating a case these conditions should never be lost sight of. It will therefore be convenient before speaking of the different kinds of stricture to say a word or two on the other causes which may give rise to difficulty in swallowing, since the diagnosis of stricture of the œsophagus has often to be made by a process of exclusion of the other forms of dysphagia.

Dysphagia.—The causes of this condition may be divided into those situated within the food passages and those outside. Among the former are certain conditions of the pharynx, as (1) tumours, especially naso-pharyngeal polypi, which may hang down into the pharynx and obstruct deglutition (page 632); (2) abscess, especially retro-pharyngeal abscess (page 717); (3) pouches of the lower part of the pharynx (page 714); (4) paralysis of the muscles of deglutition, either diphtheritic or labio-glosso-pharyngeal; and (5) impaction of foreign bodies.

Dysphagia may be the result of certain morbid conditions of the larynx, as: (1) acute laryngitis, causing œdema about the rima glottidis; or (2) chronic laryngitis, both tuberculous and syphilitic, causing thickening or ulceration about the glottis and obstructing the passage of food; or (3) it may be caused by malignant disease of the larynx. Conditions, other than stricture, in the œsophagus itself may give rise to dysphagia, as inflammation, acute or chronic, impaction of foreign bodies, and the formation of diverticula.

Among the extrinsic causes of dysphagia are tumours in the neck outside the œsophagus, principally enlarged glands, enlargement of the thyroid, and aneurism; or tumours in the thorax, aneurism of the aorta or innominate artery; mediastinal growths, enlarged bronchial glands, or sarcomatous tumours growing from the bodies of the vertebræ. Finally, the dislocated sternal end of the clavicle may press on the œsophagus and cause dysphagia.

In investigating a case of stricture of the œsophagus, all these causes of dysphagia should be borne in mind and eliminated as far as possible; especially before any attempt is made to pass an œsophageal bougie, since a serious mishap might occur, say in a case of aortic aneurism, if an instrument were passed down for the purpose of ascertaining whether a stricture existed or not.

1. **Spasmodic stricture.**—Spasmodic stricture of the œsophagus is met with at all ages and in both sexes, but is most common in females under the age of thirty. It is probably almost always associated with some local irritation, as chronic follicular inflammation or ulceration, which is frequently the result of some slight abrasion of the mucous membrane from swallowing a foreign body some time previously. The difficulty in swallowing is intermittent and uncertain, and the condition may be suspected if the patient is neurotic and there is but little emaciation and loss of strength. If the patient is asked to swallow, she will say that it is impossible for her to do so, and if she is encouraged to make the attempt will half choke in her efforts. At other times, when her attention is diverted from her condition, deglutition takes place quite normally. If an attempt is made to pass a bougie, its passage will be violently resisted by the pharyngeal muscles and the instrument be arrested at the entrance of the œsophagus; but if steady pressure is kept up for a minute or two, the bougie will glide onwards into the stomach without any difficulty.

The **treatment** consists in attention to the general health and the administration of anti-spasmodics. Any local condition about the pharynx which can be discovered as likely to set up the disease must be treated, and it will usually be found that the occasional passage of a bougie will afford relief to the patient.

2. **Fibrous stricture** of the œsophagus is the result of cicatricial contraction where the mucous membrane has been destroyed by the action of corrosive fluids which have been accidentally or intentionally swallowed; or by the impaction of a foreign body and subsequent ulceration, or, in rare instances, from syphilitic or tuberculous ulceration. The stricture is almost always situated at the upper part of the œsophagus (fig. 275), though it has been said to occur at the cardiac end of the tube from the contraction of a cicatrix formed by a gastric ulcer.

3. **Malignant stricture** of the œsophagus. This is by far the most common form of the disease. It usually occurs in individuals advanced in life, and rarely if ever before the age of forty. It is found more frequently in the male than in the female. Its most common situation is at the commencement of the œsophagus, behind the cricoid cartilage, but it is also not infrequently found about the middle of the tube, where it crosses the left bronchus, or at its cardiac extremity, and may indeed be found in any part of the canal. In the vast majority of cases the form of disease which occurs is squamous epithelioma, except in those cases where the stricture is close to the cardiac orifice of the stomach, when columnar epithelioma is the form of disease usually met with. It manifests itself as an annular constriction, which speedily ulcerates and forms an excavated irregular sore surrounded by indurated margins (fig. 276). The ulcer spreads and may open into the trachea, the pleural cavity, or into one of the large blood-vessels in the neighbourhood, and cause death from hæmorrhage.

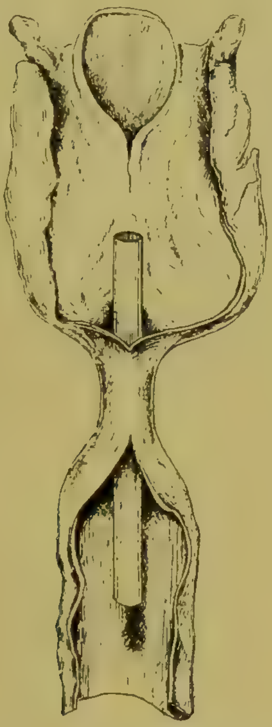

FIG. 275.—Fibrous stricture of the upper part of the œsophagus. (From the Museum of St. George's Hospital.)

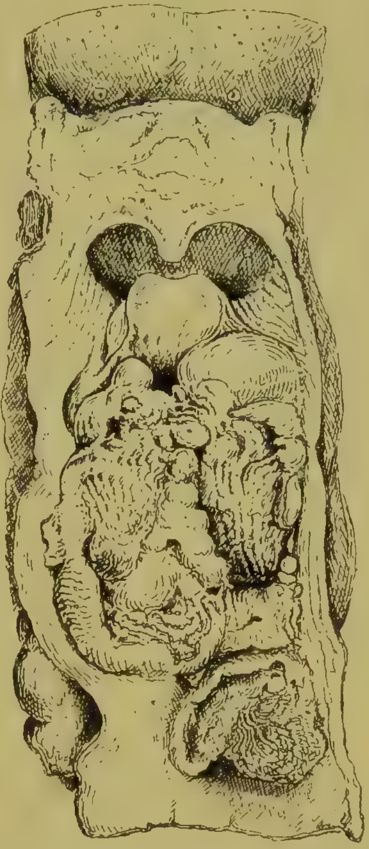

FIG. 276.—Malignant stricture of the œsophagus. (From the Museum of St. George's Hospital.)

Symptoms of organic stricture.—The first symptom observed is difficulty in swallowing. This as a rule comes on slowly; the patient notices that occasionally if he attempts to bolt an incompletely masticated bolus of food it appears to be arrested and is only swallowed with difficulty. Then he finds that this frequently recurs, and after a time that he is unable to swallow any solid food without its appearing to stick at one particular point in the gullet. Now he notices that the food sticks longer, and instead of his eventually getting rid of it, it regurgitates and is brought up again exactly in the condition in which it was swallowed. If this regurgitated food is examined, it will be found to have an alkaline reaction, proving that it has not been mixed with the gastric juice. Sometimes, however, the difficulty in swallowing comes on quite suddenly. At first it is often unaccompanied by pain; later on a good deal of pain is referred to the site of the disease. The patient now begins to retch up a quantity of frothy fluid, and when ulceration has taken place the food comes back stained with blood and mixed with pus. The patient rapidly emaciates, especially in the malignant form of the disease, and death occurs much more commonly from exhaustion than from perforation. When the disease is situated in the upper part of the gullet, a tumour may be felt in the neck, behind the larynx and usually more pronounced on the left side, and the lymphatic glands in the neighbourhood may be found to be secondarily enlarged. By auscultation of the œsophagus it is sometimes possible to detect the stoppage of the food current at the seat of stricture. The patient is made to swallow some gruel or thick fluid, while the surgeon listens with a stethoscope placed on the back in the middle line. Attempts have been made by means of an œsophagoscope to see the stricture, but hitherto without much success.

The **diagnosis** of a malignant from a simple fibrous stricture of the œsophagus may be made by the history of some injury in the fibrous form; by the age of the patient—a stricture occurring before the age of forty being probably not cancerous; by the rapidity with which the difficulty in swallowing increases; by the general appearance of the patient, and the rapidity with which emaciation comes on; and by an external examination of the parts, when the diagnosis of a cancerous stricture may sometimes be assisted by a swelling being felt in the neck or by an enlargement of the glands.

The diagnosis of stricture of the œsophagus may be confirmed by the passage of an œsophageal bougie, but this must always be done with the very greatest care, and is rarely permissible in those cases where there is any suspicion that ulceration has taken place. The bougie should be flexible, those known as the silk web elastic bougies being the best. A small one, rather larger than a No. 12 English catheter, should be first passed. It should be well warmed by soaking it in hot water for a few minutes, and then lubricated with a little glycerine. The surgeon, standing in front and to the right of the patient, who should be seated, with his head bent forwards, passes the forefinger of his left hand over the dorsum of the tongue, and guiding the bougie along this, pushes it to the back of the pharynx. Aided by the forefinger, with gentle pressure, the bougie passes over the top of the larynx into the œsophagus, and is then pushed steadily and gently on until it meets the obstruction, if any exists. The distance from the mouth to the cardiac orifice of the stomach is sixteen inches, and if the length of the bougie from the point it enters the mouth to the seat of obstruction is taken, and six inches, the distance from the mouth to the commencement of the œsophagus, is deducted, the remainder will indicate the position in the gullet at which the stricture is situated. If the bougie passes down into the stomach without apparently meeting with any obstruction, one of larger size may subsequently be passed. It is rarely desirable, if there is any suspicion that the stricture is of a malignant nature, to use a smaller one than that above indicated.

Treatment.—The treatment of **fibrous stricture** of the œsophagus, when a bougie can be passed, is best conducted by simple dilatation. By passing bougies of gradually increasing size, every day or every other day, and allowing them to remain in the stricture as long as the patient can bear to retain them, most cicatricial strictures can be gradually dilated so that the patient can swallow without difficulty. But unfortunately this treatment does not cure the stricture, for if the introduction of the bougie is omitted, recontraction very speedily takes place; so that it is necessary to instruct the patient to pass a bougie for himself, and impress upon him the necessity of his continuing to do so for the rest of his life. More favourable results have been attempted to be brought about by forcibly dilating the stricture by means of expanding india-rubber bags introduced into it, or by means of division by a concealed knife (internal œsophagotomy), but, as a rule, no good results have followed these attempts, and the latter of the two is far from being devoid of danger. In those cases where the stricture can be dilated, but speedily contracts, Symonds' tube should be introduced. The instrument consists of a gum-elastic tube, about six inches in length, with a funnel-shaped extremity. This is passed, by means of a whalebone introducer, through the stricture so that the funnel-shaped dilated extremity rests on the constriction, which prevents it passing downwards into the stomach. To the free margin of the funnel two silk threads are attached and are left hanging out of the mouth, so that the tube can be easily withdrawn if required. Through this tube the patient can swallow, and the pressure of it prevents the cicatricial tissue from contracting. Symonds relates a case where such a tube was worn for eight months. In cases where no instrument can be passed through the stricture or where dilatation has failed to relieve, an attempt should be made to divide the stricture by Abbe's string saw. A small split shot is clamped on to a piece of silk, and this is swallowed by the patient and allowed to find its way into the stomach. When this is judged to have taken place, the stomach is opened and the shot sought for and pulled out of the wound. A piece of strong whip-cord is now attached to the end of the silk hanging from the mouth and pulled through the stricture and out of the stomach. By a to-and-fro sawing movement the whip-cord is made to divide the stricture, and a Symonds' tube is inserted and left in, so as to prevent recontraction. Should this fail, the stomach should be sutured to the wound in the abdominal wall, and the gastrotomy converted into a gastrostomy. In those cases where the stricture is situated at the gastric orifice, arising probably from the contraction of a cicatrised gastric ulcer, gastrotomy should be performed and the stricture dilated with the finger; and in those cases where the stricture is situated quite at the upper part of the gullet, it might be possible to perform an œsophagostomy in the neck below the stricture.

The **treatment of malignant stricture** is unsatisfactory, and means can only be taken to palliate the symptoms and perhaps prolong life a little, since the disease is inevitably fatal. Attempts have been made by Billroth and others to excise a cancerous deposit in the upper part of the œsophagus, but the operation is not usually regarded as justifiable. As a rule no attempt should be made to dilate the stricture with bougies, but in a certain number of cases Symonds' short tube may be passed through the stricture and left in, with great comfort to the patient; but sooner or later this treatment becomes impossible, and the pressure of the tube against the diseased tissues and its occasional removal for cleansing purposes is liable to cause ulceration and often hæmorrhage, which hastens the patient's death. The operation of gastrostomy—making a fistulous opening into the stomach—certainly holds out the best hope of giving ease to the patient and rendering the remainder of his life as comfortable as possible. In order, however, to be of much use, this operation ought not to be deferred too long, as was formerly the custom, until the patient—almost moribund, and worn out by the miseries of a long starvation—is not in a condition to stand a necessarily severe proceeding. If performed early the operation is not dangerous, and is followed by the greatest relief from suffering for the few remaining months that the patient has to live.

Gastrostomy.—The operation of gastrostomy may be performed in several different ways. Formerly it was done by the *direct* method: the abdomen was opened, a portion of the anterior wall of the stomach was withdrawn from the abdomen and sutured to the external wound; after adhesions had taken place it was opened. Recently the operation has been performed by what is known as the *valvular* method, which not only possesses the advantage that the stomach can be opened at once, but also prevents prolapse of the mucous membrane, and escape of the gastric fluid, which irritates the surrounding skin and militates considerably against the direct operation.

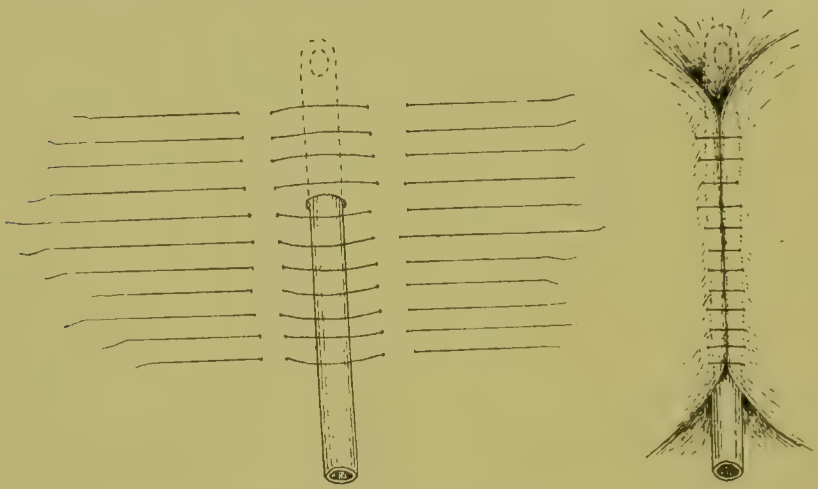

FIG. 277.—Witzel's method of performing gastrostomy.

There appears to be a considerable difference of opinion as to the best method of performing gastrostomy. When the stomach can be drawn out far enough from the wound, the operation may be performed by the Ssabanijews-Franck method, or by Kader's, Senn's, or Marwedel's plan. Of these, probably the first is the best, and it will be sufficient if this operation is described in detail. In those cases where the stomach is not freely movable and cannot be drawn out of the wound, the method recommended by Witzel should be resorted to. This consists in burying an india-rubber tube in the wall of the stomach for about two inches, by inclosing it in a fold of peritoneum, which is sutured over it by Lembert's suture (fig. 277). One end of the tube is introduced into the stomach through a small incision, and the other end is made to project through the external wound in the abdominal wall. The stomach around the tube is sutured to the parietal peritoneum in the neighbourhood of the wound.

The great disadvantage of this operation is that the tube can never be dispensed with.

The Ssabanijews-Franck operation. — The abdominal wall may be divided by an oblique incision, starting an inch and a half from the median line of the body, and carried parallel with the lower margin of the left costal arch and about a finger's breadth below it, for a distance of two and a half inches ; or, what is perhaps better, by a vertical incision beginning opposite the eighth intercostal space, two inches from the median line, and carried downwards for three inches. In this incision, when the rectus muscle is exposed, its fibres are separated with a steel director and not cut. When the peritoneal cavity has been opened, the anterior wall of the stomach is pulled out of the wound, and a silk suture passed through its muscular and serous coats at the point selected for opening the viscus. This is held by an assistant, so that the stomach forms a long conical diverticulum protruding from the external wound, and the parietal peritoneum and the posterior layer of the sheath of the rectus are sutured around it (fig. 278, A). A second incision is made through the skin, over the margin of the costal cartilage, above and a little to the outer side of the first incision. With a pair of dressing forceps a track is formed under the skin in the subcutaneous tissue from the one opening to the other, and the diverticulum of the stomach is drawn along this track by means of the suture inserted into it, so that its apex appears at the second opening. A small perforation is now made into the stomach through this protruding apex, and its margins carefully and accurately sutured to the margin of the external wound (fig. 278, B). The remainder of this incision and the whole of the first incision are then closed in the ordinary way, and the wound dressed. If considered desirable, food may be

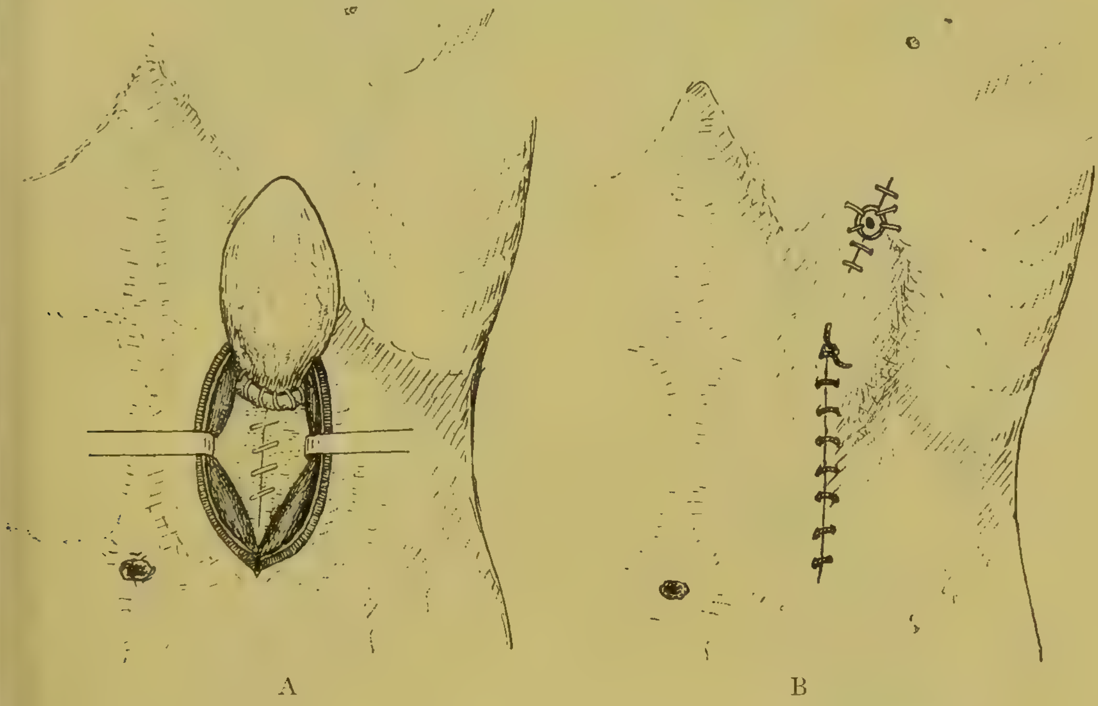

FIG. 278.—The Ssabanijews-Franck method of performing gastrostomy.

introduced into the stomach at the time of the operation, for the diverticulum being gripped by the rectus muscle, and being bent over the costal margin in the form of an angle, constitutes a curved tube through which escape of fluid is scarcely likely to occur.

The great advantage of this method is that it requires no permanent tube and does not give any trouble from leakage. Both Kader's and Marwedel's plans require a permanent tube. In Marwedel's method the tube is made to run between the muscular and mucous layers of the stomach wall (fig. 279); and in Kader's operation the tube is inserted through a small opening directly into the stomach. It is fixed there by two rows of Lembert's sutures, the second being placed over the first, and the summit of the fold is united to the parietal peritoneum (fig. 280). The rest of the wound in the abdominal wall is then closed. Senn's method does not necessitate the use of a tube. He draws out a conical piece of the stomach, and inserts two purse-string sutures of thick catgut through the serous and muscular coats about two and a half inches from the apex of the cone. These sutures are drawn tightly, so as to pucker up the stomach, and are then covered, according to the practice of Senn, by a layer of the great omentum. Other surgeons, Abbe for example, do not consider this necessary. The cone is now sutured to the margins of the

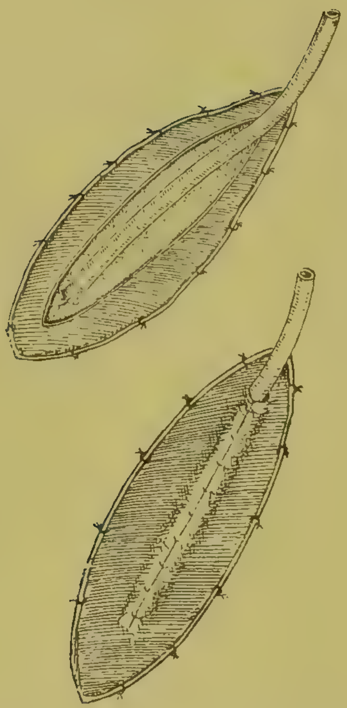

FIG. 279. Marwedel's method of performing gastrostomy.

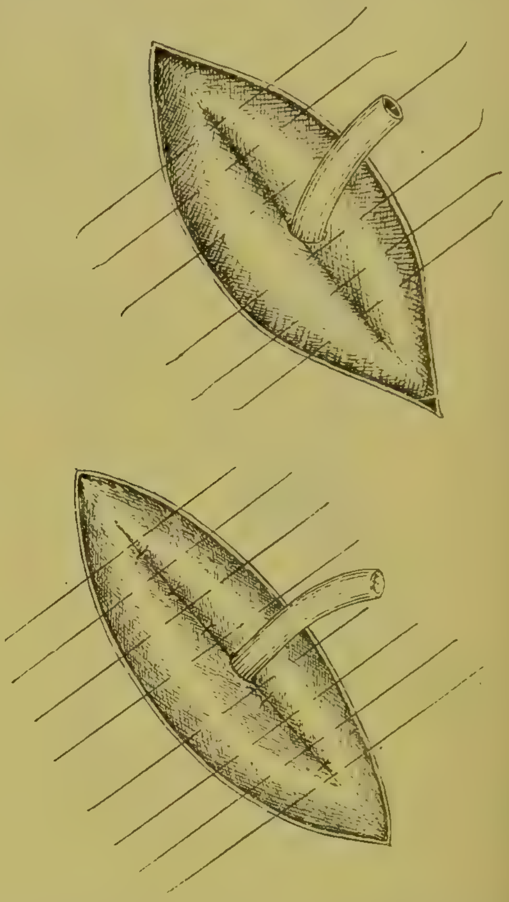

FIG. 280.—Kader's method of performing gastrostomy.

wound in the abdominal wall, and the parts left for a couple of days. At the end of this time an opening is made in the apex of the cone, and the edges of the incision are turned inwards into the cone, and fixed by means of Lembert's sutures so as to form a permanent valve, and a rubber tube introduced. In cases of urgent necessity the opening in the cone may be made immediately.

DISEASES OF THE LARYNX

Laryngitis may be either acute or chronic. The *acute form* may arise from several different causes, and presents itself under two distinct and separate varieties.

1. **Acute catarrhal laryngitis,** in which the disease arises from exposure to cold, or from extension of catarrh from the nose and pharynx ; from overstrain of the voice, especially in those who are addicted to the use of tobacco; and from the inhalation of irritant vapours. The inflammation in these cases is confined to the mucous membrane.

Symptoms.—Acute catarrhal laryngitis is most commonly met with in the male adult, and is rare in children. Pain is complained of about the larynx, greatly increased on coughing, and the voice is hoarse, and in some cases entirely lost. There is constant hawking and coughing and attempts to clear the throat, and a little mucous expectoration, which may be occasionally tinged with blood. There is rarely any serious dyspnœa, but a considerable amount of constitutional disturbance and fever. Upon examination with the laryngoscope, the mucous membrane of the larynx will be seen to be intensely injected.

Treatment.—The patient should be kept in bed, in a warm, equable, and moist atmosphere. He should inhale steam, to which compound tincture of benzoin may be advantageously added (ʒj to Oj), and hot fomentations should be applied to the throat. The acute symptoms speedily subside under treatment, but a condition of chronic laryngitis may remain and persist for some considerable time.

2. **Acute œdematous laryngitis** may arise from an extension inwards of erysipelas from the face; from the inhalation of sewer gas; from the poison of contagious fevers, scarlet fever, smallpox &c., and from injury, scalds, corrosive fluids, &c.

The inflammation is attended with considerable effusion into the submucous tissue, so that the mucous membrane becomes swollen and pulpy, and of a dusky red hue. The infiltration is confined to the upper part of the larynx, and does not extend beyond the vocal cords, since there is an absence of submucous tissue over these structures, the mucous membrane being intimately adherent to the cords. The infiltration may be so great as to obstruct respiration.

Symptoms.—The disease generally begins with the symptoms of ordinary sore throat. The patient is feverish and complains of pain, especially in swallowing or speaking. Then inspiration becomes painful and difficult, and the patient's countenance presents a distressed and anxious appearance, and he is constantly coughing and hawking up small hard masses of inspissated mucus, which are supposed to come from the ventricle of the larynx. The voice is at first hoarse, and then entirely lost or converted into a whisper. The febrile disturbance becomes increased ; the dyspnœa more and more urgent ; the face livid and bathed in sweat ; the pulse small and intermittent, and death ensues either suddenly from spasm, or more slowly from suffocation without spasm, or still more gradually from obstruction preceded by unconsciousness.

Treatment.—Great relief is often afforded by free scarification of the swollen tissues. This is done by means of a sharp-pointed bistoury, guarded to within half an inch of its point, the parts being illuminated by the laryngoscopic mirror. The patient is afterwards inclosed in a steam tent, and should constantly inhale steam to which compound tincture of benzoin or tincture of henbane has been added. The throat may be mopped out with a solution of nitrate of silver (ʒj to ℥j), or with a 10 per cent. solution of cocaine. Hot fomentations should be applied externally. Occasionally antimonial wine (♏ iij) and tincture of aconite (♏ ij), given every half-hour until some effect is produced on the pulse, is of use. If, notwithstanding these remedies, the difficulty in breathing increases, no time should be lost, but intubation, which is especially indicated in these cases, or laryngotomy should be performed.

Chronic laryngitis may be simple, catarrhal, tuberculous or syphilitic.

1. **Simple catarrhal (follicular) laryngitis** may result from an acute attack or may arise from constant strain in forced vocalisation. It consists of an inflammation of the glandular follicles of the mucous membrane. It is characterised by an alteration in the voice and a sense of effort in sustaining it. With this there is a sensation of dryness and uneasiness about the larynx, and the patient is constantly hemming and hawking. The general health and spirits become depressed. It is often associated with a granular condition of the mucous membrane of the pharynx (page 716).

The **treatment** consists in giving perfect rest to the voice, by abstaining from speaking in public for some considerable time, and by applying astringents to the throat, such as solutions of nitrate of silver, sulphate of copper, or tincture of iodine. The inhalation of chloride of ammonium very often gives considerable relief.

2. **Tuberculous laryngitis** consists in a deposit of tubercle beneath the mucous membrane, which caseates and breaks down, leading to the formation of ulcers, and when extensive results in destruction of the epiglottis or necrosis of the cartilages. Most frequently it is only a part of a general condition of tuberculosis, but in some cases the disease may commence in and be confined to the larynx. The chief symptoms are: at first huskiness and then gradual loss of voice, accompanied by cough, expectoration, night sweats, emaciation and death. In many cases there is also difficulty and pain in swallowing. In the early stages, upon laryngoscopic examination, a very characteristic pyriform swelling of the mucous membrane covering the arytenoid cartilages may be seen, and later on numerous small ulcers are found on the aryteno-epiglottidean folds, the posterior surface of the epiglottis, and about the upper opening of the larynx. In doubtful cases a diagnosis may sometimes be made by detecting the tubercle bacillus in the frothy muco-purulent expectoration.

The **treatment** consists mainly in dealing with the general condition of the patient, and this naturally comes under the care of the physician. When the disease primarily affects the larynx and is confined to this part, considerable good may be effected by scraping the ulcers and then applying pure lactic acid. This may be done by the expert through the mouth, but is much more effectually accomplished by performing a preliminary thyrotomy, so as to freely expose the whole of the laryngeal cavity. The dyspnœa in these cases is rarely sufficiently severe to require tracheotomy, but it has been proposed by some to perform this operation in the early stages of the disease, so as to give physiological rest to the larynx.

3. **Syphilitic laryngitis.**—Syphilis may affect the larynx either in the secondary or tertiary stage of the disease. As a *secondary* affection it occurs in the form of mucous tubercles, which may be seen with the laryngoscope as little rounded greyish elevations studding the mucous membrane of the upper part of the larynx. Occasionally superficial ulcers may be seen. They do not, as a rule, produce much trouble beyond hoarseness, or loss of voice. The *tertiary* condition consists in a gummatous infiltration, especially about the epiglottis and aryteno-epiglottidean folds, or in the formation of isolated gummatous deposits. These soften and give rise to wide-spread ulceration, very often implicating the perichondrium and leading to extensive necrosis of the cartilages and complete destruction of the epiglottis. Should the patient recover and the ulceration heal, extensive cicatricial contraction will take place, which may completely occlude the larynx. The symptoms are hoarseness, gradually going on to complete loss of voice, accompanied by dyspnœa, and when ulceration has taken place, abundant muco-purulent expectoration. In the early stages the deposit is to be recognised from that of tubercle by the history of the case, the general condition of the patient and the appearance of the nodulation, which in laryngeal phthisis is pale and grey in colour, and in syphilitic is usually dark red, darker than the surrounding mucous membrane.

The **treatment** consists in dealing with the general syphilitic condition, and applying a solution of corrosive sublimate (gr. ii to ℥i) locally to the ulcers with a laryngeal brush. The inhalation of calomel vapour is often beneficial, especially in the secondary form. If the dyspnœa becomes urgent, tracheotomy will be required.

Tumours of the larynx.—Both innocent and malignant tumours occur in the larynx. Of the former, the most common is the papilloma, and then the fibroma; but many other forms of tumour are occasionally met with, as adenoma, myxoma, chondroma, angioma, and rarely cystic tumours. The only one which requires special mention is the papilloma, not only on account of its frequent occurrence, but also on account of its tendency to assume a malignant type and degenerate into epithelioma. The papilloma occurs in wart-like masses, which usually grow from the true vocal cords. It may be pedunculated or sessile, solitary or multiple, and is found at all ages, though more commonly in patients over the age of thirty. It gives rise to hoarseness, constant cough and dyspnœa; but a diagnosis can only be made with the laryngoscope.

The **treatment** consists in cocainising the larynx, and then seizing and twisting off the growths with laryngeal forceps. Should this fail, as it may do if the tumours are numerous and sessile, the operation of thyrotomy should be performed, the growths removed with scissors, and the bleeding points touched with nitrate of silver. The operation is only indicated when there is danger to life from dyspnœa.

Malignant tumours of the larynx.—Both carcinomatous and sarcomatous tumours occur in the larynx, but the former are much the more common of the two, and are almost always of the squamous-celled variety. The disease usually commences near the base of the epiglottis or on the vocal cords as a papillary overgrowth. This spreads and ulcerates (fig. 281). The disease may also invade the larynx by extension from the pharynx or neighbouring parts. This latter form of the disease is more rapidly fatal than the intrinsic variety. As the morbid growth extends, it invades all the tissues of the larynx, destroys the cartilage, and spreads to other parts. The lymphatic glands in the neighbourhood become involved, and death occurs from dyspnœa and exhaustion.

Symptoms.—In the early stage, when the disease is confined to one side of the larynx, the symptoms are hoarseness and partial loss of voice, some interference with respiration and an irritable cough. Later on there is expectoration of blood-stained mucus, which is often very offensive; very severe pain; increasing dyspnœa, which is occasionally spasmodic; dysphagia and rapid emaciation. The nature of the disease is verified by laryngoscopic examination, and sometimes it is desirable to seize and remove a small portion of the growth with laryngeal forceps, for purposes of microscopic examination.

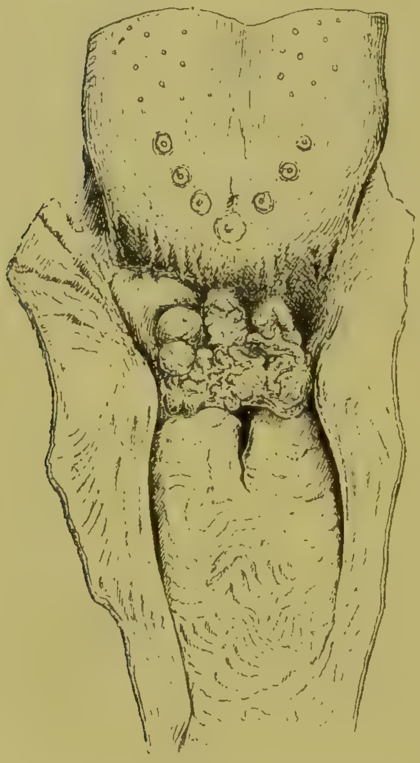

FIG. 281.—Epithelioma of the larynx. (From the Museum of St. George's Hospital.)

Treatment.—In deciding upon what treatment shall be adopted in a case of malignant disease of the larynx, the first point to determine is whether the disease is intrinsic and confined to the larynx, or extrinsic and involving other structures. In these latter cases any radical operative measure is generally out of the question. When the disease is confined to the larynx, and especially if it is unilateral, the first step should be to perform a low tracheotomy, and when the patient has become habituated to the wearing of a tube, after taking means to prevent blood getting into the bronchi by packing a piece of sponge into the trachea above the tube, or by the use of a Hahn's tube, or Trendelenburg's tampon cannula, to perform a thyrotomy. By this means the exact extent and connection of the growth can be ascertained, and three courses are now open to the surgeon. (1) If the disease is limited to the soft parts, and has not invaded the cartilages, he may proceed to cut away the whole of the diseased tissues, with as wide an area of surrounding healthy tissue as is possible. The bleeding is then arrested, and the two halves of the thyroid cartilage accurately adjusted and sutured. (2) If the disease is unilateral, but has invaded one half of the thyroid cartilage, a partial resection of the larynx may be performed, and one ala of the thyroid cartilage removed, and, if necessary, one half of the cricoid. This is done by raising the soft parts from the outer surfaces of the cartilages, and separating these structures from their attachment to the pharynx by means of a raspatory. The thyro-hyoid membrane is then divided with blunt-pointed scissors, and the superior cornu cut through. The cricoid cartilage is divided in the middle line, in front and behind, with cutting pliers, and the divided half of the larynx separated from the upper ring of the trachea. A few touches here and there with the point of the knife will now effect its removal. When this operation is performed the chances of recovery are far greater than in excision of the whole larynx, and the after condition is much more satisfactory, the patient being able to swallow easily and speak distinctly though perhaps hoarsely, without artificial aid. (3) If both sides of the larynx are involved and the cartilages implicated, the only resource of the surgeon is complete extirpation of the larynx. It is a question whether this operation is ever justifiable for epithelioma, though it may be for sarcoma. It is a proceeding of great severity, entailing a large amount of shock, and is especially liable to be followed by sepsis, and the after condition of the patient is one of great misery, often necessitating his being fed by means of a tube, on account of the ability to swallow being lost, and requiring the wearing of an artificial instrument in order to enable him to make any intelligible articulate sounds.

In cases where no radical operation for the removal of the disease can be performed, tracheotomy will be required sooner or later, and usually gives great ease and comfort to the patient.

DISEASES OF THE PAROTID GLAND

Parotitis, or Inflammation of the Parotid Gland, is met with in several different forms.

1. **Specific parotitis** (*mumps*) is an infective inflammation, due to a specific cause. It occurs especially in children, is of a very contagious character, has a distinct period of incubation, is generally epidemic, and one attack usually renders the patient immune from further infection.

The period of incubation is generally three weeks, though cases have been known to occur where it is only a fortnight. It usually attacks one gland, though in some cases both may be affected. It runs a definite course, and subsides in a week or ten days without suppuration. In a certain number of cases, probably about two or three per cent., a metastasis takes place, and in males inflammation of the testicle is set up, and more rarely, in females, inflammation of the ovary or breast. When the ovaries become affected, the patient, during the subsidence of the mumps, complains of pain in the region of these organs, and if a vaginal examination is made, the ovary or ovaries will be felt to be enlarged and tender.

Symptoms.—The attack commences with a certain amount of febrile disturbance, accompanied by swelling of one or both parotid glands. The swelling is firm and tense, and extends from the zygoma to the angle of the jaw. The socia parotidis can generally be differentiated, swollen, hard and tender, lying on the masseter muscle. Great pain is often complained of on account of tension of the fibrous structures covering the gland, and mastication becomes difficult and extremely painful. The lymphatic glands in the neighbourhood are sometimes enlarged, and suppuration may occur in them. In those cases in which orchitis is secondarily set up, atrophy of the testicle may follow.

The **treatment** consists in keeping the patient in a warm, equable atmosphere; administering a brisk purge, and keeping him on slop diet. Hot fomentations applied to the part materially relieve the pain.

2. **Parotitis after injury of the abdominal or pelvic viscera.**—Inflammation of the parotid gland not infrequently follows

operations on or injuries of the abdominal and pelvic viscera, though it does not appear to be frequent in similar conditions of other parts of the body. No explanation has at present been afforded of this, though formerly it was regarded as pyæmic. Stephen Paget, who has carefully studied this condition, has proved, however, that this is not so, at all events in the majority of cases. The inflammation is very liable to run on to suppuration. The swelling of the parotid is accompanied by a slight amount of fever, and comes on at very variable periods after the injury which has given rise to it.

3. **Suppurative parotitis.**—Inflammation of the parotid gland running on to suppuration may arise in the course of scarlet fever, measles, smallpox, or typhoid fever; or it may occur during septicæmia after childbirth, or in the course of pyæmia. This is a much more serious condition, since, on account of the pus being confined by the dense fascia covering the gland, it has a tendency to burrow in all directions, and the constitutional symptoms are very severe.

The **treatment** of these two forms of parotitis is in the early stage the same as the treatment of mumps; but as soon as there is the slightest indication that pus is forming, a free incision into the gland should be made. This must be done with care to avoid wounding the facial nerve, the incision being made parallel to this structure.

Tumours of the parotid gland may be innocent or malignant. The innocent tumour, the so-called *parotid tumour*, is one of considerable interest, as it is really a mixed tumour, being made up of several forms of growth. It usually consists of fibrous tissue, cartilage, and myxomatous tissue, and to this is sometimes added a certain amount of adenomatous tissue, resembling the structure of a racemose gland. In some of these tumours the cartilaginous element largely predominates, and then it often undergoes a mucoid softening and forms a cyst or cysts in the growth, which contains a glairy fluid. These tumours generally commence in the superficial part of the gland, and at first small and growing slowly, they later on grow more rapidly, and attain a very considerable size (fig. 282). They are firm, elastic to the feel, somewhat lobulated or bossy on the surface, freely movable on the parts beneath, and the skin is stretched and thinned over them, but not adherent to them. When they have attained a considerable size they may become softer, and fluctuation may be perceptible, indicating the presence of a cyst or cysts. They as a rule cause no pain, but mastication may be interfered with.

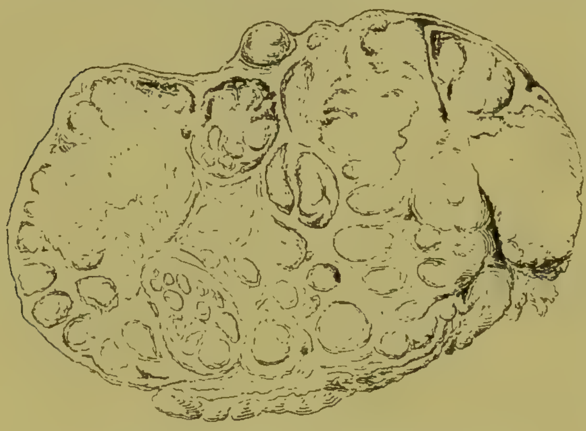

Fig. 282.—Tumour of the parotid. (From the Museum of St. George's Hospital.)

The **treatment** consists in removing the tumour. This is generally a comparatively easy matter when it has not attained a large size, but may sometimes be attended with considerable difficulty when the tumour has sent prolongations inwards among the deeper parts. The main structure to avoid is the facial nerve. This is usually situated on the deeper aspect of the tumour, and is frequently adherent to its capsule; it may, however, be superficial to it, and this fact should always be borne in mind, and any incision into the capsule made in a horizontal direction. In removing these growths, the surgeon should always make a free incision over the most prominent part of the swelling, so as to be able to thoroughly expose the capsule; when this has been done, and the capsule freely opened, the tumour can usually be enucleated without difficulty, but care must be taken that every lobule is removed. The transverse facial artery is frequently divided, but can easily be secured; in the deeper part of the dissection the position of the temporo-maxillary vein and the external carotid artery must be borne in mind.

Malignant tumours of the parotid may be either sarcomatous or carcinomatous. The sarcoma, though it may occur as a primary growth in the gland, is usually caused by an ordinary parotid tumour undergoing sarcomatous changes. A parotid tumour, which has existed, it may be, for years, undergoing a very slow and painless enlargement, suddenly springs into activity, grows rapidly, becomes fixed to surrounding parts; the skin becomes involved, adherent to the tumour, then gives way and fungation takes place. If such a tumour is examined microscopically, it will be found to contain spindle-shaped cells and other evidence of sarcomatous change, in addition to the original elements of the tumour.

The carcinomatous tumours are not so common, and are generally of the soft or encephaloid variety, though the hard scirrhus cancer has been met with in this situation.

Symptoms.—Malignant tumours of the parotid, whether sarcoma or carcinoma, grow rapidly, are generally more or less ill defined in outline, and soon become firmly fixed to surrounding parts and adherent to the skin, which becomes purplish red, infiltrated with the growth, and finally gives way and fungates. The tumour is soft and apparently semi-fluctuating when it is an encephaloid carcinoma or a sarcoma, and occurs about middle life; but is hard and tuberous, and usually occurs after middle life, when it is scirrhus. The **diagnosis** between innocent and malignant growths may generally be made by attention to these points. The malignant tumour, as it grows, causes pressure on surrounding parts. It may press on the internal jugular vein, causing venous obstruction, or on the internal carotid artery, interfering with the supply of blood to the brain, or it may implicate the facial nerve, producing facial palsy. In some cases it may grow inwards and project into the pharynx and cause dysphagia.

Treatment.—These cases are rarely amenable to treatment by removal, except in quite the early stage, and even in these the prognosis is not favourable, since the disease in the majority of cases speedily returns. If the attempt is made, efforts should be directed to extirpate the whole gland by free external incisions and by ligaturing the external carotid before the dissection is commenced. The facial nerve is necessarily divided and a part of it removed, and therefore permanent palsy must be a consequence of the operation. In the majority of cases, palliative treatment is all that can be adopted.

Affection of the parotid duct.—The duct of the parotid gland sometimes becomes obstructed by a salivary calculus. If this is allowed to remain, it ulcerates its way through the duct; an abscess forms in the cheek, which is opened or bursts, and a salivary fistula results (see page 634). The obstruction causes pain and swelling in the gland after food has been taken; and if this is long continued, the gland becomes chronically enlarged. The calculus can usually be felt through the mucous membrane of the mouth, or by passing a probe down the duct. It may be easily removed by an incision through the mucous membrane. Salivary calculi are much more commonly found in the duct of the submaxillary gland.

DISEASES OF THE THYROID GLAND

Atrophy of the thyroid gland may occur and may result in an almost entire destruction of the gland structure ; this is the cause of a remarkable disease named *myxœdema*, and is identical with the condition termed *cachexia strumipriva*, which is produced when the whole of the thyroid gland is excised in cases of goitre, or when the gland is removed experimentally in monkeys. The condition closely resembles the *cretinoid state*, and it is more than probable that the three conditions, myxœdema, cachexia strumipriva, and cretinism, are due to loss of function of the thyroid body ; the latter of these diseases occurring from conditions present during intra-uterine life. The cause of this atrophy of the thyroid is unknown. It occurs almost invariably in women during the adult period of life.

Myxœdema.—It is necessary to allude briefly to the symptoms of this condition, though the disease falls more properly under the care of the physician. It is characterised, as Dr. Ord expresses it, by an 'unwieldy state of mind and body,' and is due to the tissues of the body being invaded by a jelly-like mucus. The body, and the face especially, is swollen, the skin being waxy looking and anæmic, but not pitting on pressure. The skin is also dry, harsh, and roughened, and there is rarely any perspiration. The intellect is in a torpid state, but is not impaired ; the patient thinks slowly, speaks slowly, and all the movements are slow and languid, the muscles being apparently toneless and torpid. The heat of the body is always below normal, ranging often as low as 94° F. There is, as a rule, no organic disease of any of the viscera to be discovered in the early stages of the condition ; but later on the urine becomes albuminous, and the mind becomes unhinged, hallucinations or delusions set in, and the patient sinks gradually into a comatose state and dies. The treatment consists in the administration of thyroid gland as a food, or medicinally in the form of an extract.

Cretinism is a condition of idiocy arising from hereditary causes, associated with imperfect development and deformity of the whole body, and closely resembles myxœdema.

Goitre or **Bronchocele.**—Enlargement of the thyroid body, when it is not due to inflammatory causes, is known under the name of *goitre* or *bronchocele*, and presents itself under several different varieties.

Causes.—The etiology of bronchocele is still uncertain, and the disease has been attributed to several different causes. It was believed formerly to be due to the water that the patient drank, and water containing large quantities of lime or water produced by melted snow have both been stated to be the cause of the disease. This has now been proved not to be so. Again, air and locality have been regarded as factors in its production : especially those localities where there is little sunshine, as in valleys, in mountainous districts which run north and south, and into which the sun does not easily penetrate ; or cellars or kitchens in narrow courts of large towns, where also there is little sunshine. The most recent theory is that it is due to the absence of iodine in the air or drinking water. At all events it is well known that iodine in combination with albumin is a constituent of the normal secretion of the thyroid body, and it has recently been discovered that it is absent in cases of bronchocele. If the absence of iodine is therefore the cause of the disease, the enlargement must be regarded as of a compensatory character. The disease is endemic, and in this country is most frequently found in the hilly parts of Derbyshire, hence its synonym, *Derbyshire neck*. It is very common in Switzerland. It occurs much more commonly in women than in men, and in the former is frequently larger during menstruation than at other times.

Varieties.—The chief forms of bronchocele are: (1) the simple or parenchymatous, (2) the fibrous, (3) the pulsating, (4) the cystic, and (5) the exophthalmic; but in addition to these we may get enlargement of the thyroid body from inflammation or from the growth in it of a tumour either innocent or malignant.

1. **Simple** or **parenchymatous bronchocele.**—This may be considered as the type of the disease, and in it all the constituents of the gland are relatively increased. There is no marked change in structure. The acini are slightly enlarged and contain a colloid material, and the fibrous stroma is increased in quantity; the gland is larger than normal, and may sometimes attain a very considerable bulk (fig. 283). The whole gland is usually involved, but the enlargement may be confined to one lobe. The disease begins with slight fullness of the neck, so that the patient notices that she is unable to wear her ordinary collars. Then a

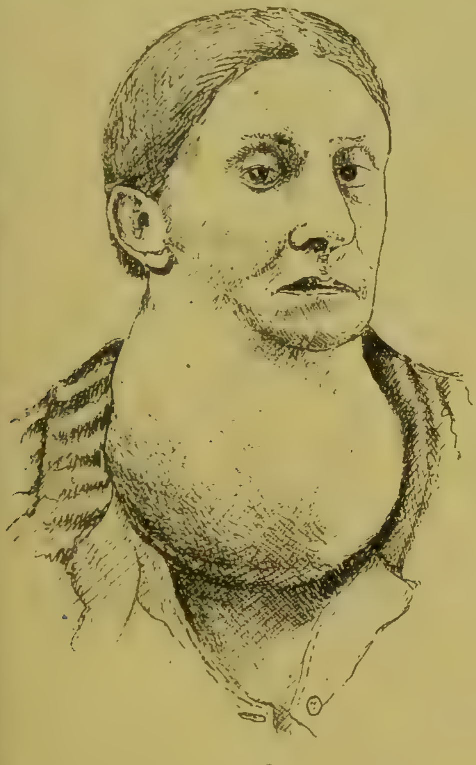

FIG. 283.
Enlargement of the thyroid gland.
(From a photograph.)

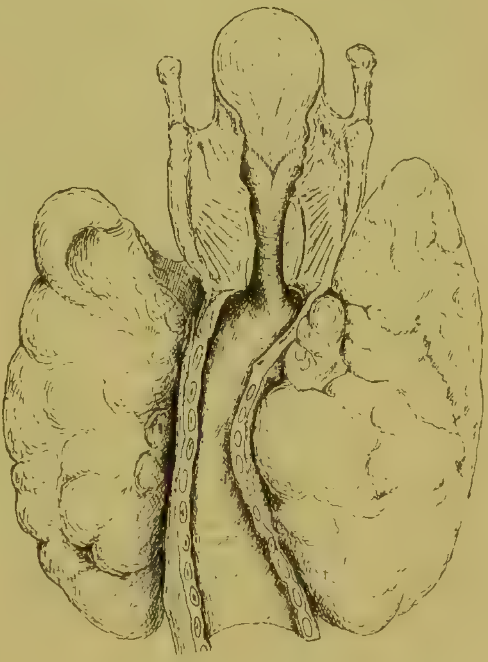

FIG. 284.—Enlargement of the thyroid body, pressing upon and constricting the trachea. (From the Museum of St. George's Hospital.)

swelling is to be observed, which, when the whole gland is involved, embraces the upper part of the trachea and assumes the shape of the normal gland. It is soft, elastic to the touch, and moves upwards with the trachea during the act of swallowing. Later on, if the tumour reaches a considerable size, the voice becomes harsh and croaking, and respiration is interfered with. Sometimes there may also be difficulty in swallowing. In some cases the large vessels in the neck may be pressed upon, and cerebral symptoms may arise from interference with the circulation in the brain. The most frequent and important changes from pressure are upon the trachea, which not only becomes flattened from side to side (fig. 284), but its cartilaginous rings may become softened and atrophied; and when one lobe of the gland is markedly larger than the other, it may become displaced to the extent of an inch or more. The recurrent laryngeal nerve is liable to be implicated, and may cause spasm of the glottis or alteration in the voice, and later on, when all the fibres of the nerve are disabled, aphonia.

2. **Fibrous bronchocele.**—In this form of bronchocele there is an abnormal increase of the interstitial stroma of the gland, without a corresponding increase in the other constituents. It begins as a parenchymatous goitre, but as it grows the interstitial tissues increase rapidly at the expense of the others, and the gland becomes hard, indurated, and irregular on the surface, and to a great extent loses the characteristic form of the normal gland. It is in these cases that the pressure effects are most marked, and especially that symptoms due to pressure on the recurrent laryngeal nerve are present.

3. **Pulsating bronchocele.**—It would scarcely seem worth while to make a separate variety of the pulsating bronchocele, for it is merely an ordinary parenchymatous swelling in which there is an excentric and distensile pulsation owing to a great dilatation of the vessels of the gland. It must not be confounded with the exophthalmic goitre, in which there is also pulsation.

4. **Cystic bronchocele.**—This form of bronchocele is due to the dilatation of the acini of the gland tissue, which form cysts, lined by epithelium and containing a variety of material. Sometimes, and especially if they are of large size, they contain a clear serous fluid ; at others, especially when they are small and multiple, they contain a thick colloid material like glue ; and again, in other cases, where blood has been extravasated into them, they contain a dark brown grumous material, like coffee grounds. In some cases there is only a single cyst, which may attain a large size and can be easily diagnosed by the fluctuation which can be felt. These are generally, however, cases of cystic adenoma, to be alluded to directly. Usually there are numerous small cysts, and then it is not easy to diagnose them from the solid forms, and only an exploration with a syringe will settle the point.

5. **Exophthalmic bronchocele** (*Graves's disease*) is a condition which is characterised by an enlargement of the thyroid body, which usually pulsates, and accompanying this is a prominence of the eyeballs, palpitation of the heart, general nervous irritability, and marked anæmia. The cause of this condition is still uncertain. Until recently it used to be believed that it was due to an affection of the cervical sympathetic, which caused a paralysis of the vaso-motor nerves and produced a chronic hyperæmia of the vessels of the gland. Recently it has been observed that symptoms very much akin to exophthalmic goitre may be produced artificially by the administration of excessive doses of thyroid extract, and it has been sug-

gested that Graves's disease may be due to excessive absorption of the secretion of the thyroid gland in those cases where it is enlarged.

The disease occurs almost exclusively in women, and usually between the ages of twenty and thirty. It is most frequently met with in the neurotic individual, and is often preceded by menstrual disturbance and anæmia. The disease usually commences with palpitation, accompanied by a sensation of fullness about the eyes and throat. The thyroid becomes enlarged, and the eyes prominent as if they were starting out of the head. The palpitation is increased by emotion or exertion, and at these times the prominence of the eyes is most marked and they become lustrous. The symptoms are often increased during the menstrual period. The course of the disease varies considerably, but in many cases has a tendency to decline and finally disappear, but during this time the patient runs the risk of being carried off by some organic cardiac lesion, by asthenia, or by some intercurrent disease.

The **treatment** of an ordinary case of solid bronchocele should be conducted in the first instance on general principles. Change of air to a warm, dry, sunshiny district is desirable, and the general health should be attended to. If the patient is anæmic, as he so often is, iron in combination with strychnine will often be found to have a remarkable effect in reducing the swelling. If there is no anæmia, iodide of potassium is usually of great service, and under its use some cases of bronchocele will entirely disappear. Locally, applications of iodine seem to produce the best results, either iodine paint or the iodide of lead ointment. In India the biniodide of mercury ointment (gr. xvi ad ℥i) has been largely employed with success. It is rubbed into the neck, and the patient then exposed to the rays of the sun. It may be employed in this country by rubbing it in, and then exposing the neck to a hot fire. In those cases where, in spite of treatment, the bronchocele continues to grow, and especially where there are symptoms of commencing tracheal pressure, some further measures are required. Various plans have at different times been advocated for the treatment of these cases: the injection of irritants, such as tincture of iodine or perchloride of iron, into the tumour; the passage of setons through the gland substance, and ligature of the thyroid arteries, need only to be mentioned to be condemned. The risks of such operations are considerable, and the results very uncertain. There are two modes by which these cases may be treated by operative interference: (1) by division or excision of the isthmus; and (2) by partial extirpation of the gland.

1. **Division of the isthmus** is a comparatively simple operation and is often productive of the best results, for not only is the respiration at once relieved, but frequently it is followed by a speedy diminution in the size of the gland. The operation consists in making an incision in the median line of the neck, exposing the isthmus, ligaturing it at either end and excising the intermediate portion. This operation should always be first tried in those cases where both lobes are equally enlarged.

2. **Partial extirpation.**—This may consist in simply scooping out a portion of the thyroid body with a sharp spoon or in removing one half of the gland. It must be borne in mind that the removal of the whole gland is followed by myxœdema, but if a sufficient portion of the secreting structure is left this result need not be feared. Probably in those cases where the enlargement is confined to one lobe, the removal of this lobe is the best plan to pursue. The operation is, however, one of considerable difficulty and some risk. There is danger of hæmorrhage, which

may be almost uncontrollable if the capsule is accidentally opened; there is a risk of wounding the recurrent laryngeal nerve or including it in the ligature passed around the inferior thyroid artery; there is also danger of wounding the internal jugular vein, which is sometimes adherent to the tumour; and of the admission of air into the veins. After the operation there is risk of cellulitis if the antiseptic measures fail, and, in some cases, of inflammation spreading down into the anterior mediastinum. The operation is performed as follows: an incision is made over the most prominent part of the tumour, and care must be taken to make it sufficiently free to thoroughly expose the whole of the growth. In most instances it will be found that an incision parallel with and a little internal to the lower half or third of the anterior border of the sterno-mastoid will be the best. This may be supplemented by a transverse cut if necessary. After the skin, platysma, and deep fascia have been divided, the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles are to be drawn inwards, or if they are at all in the way divided, and the sterno-mastoid and the carotid sheath drawn outwards with a broad copper retractor. The anterior part of the tumour will now be exposed by tearing through a little connective tissue. It must be gradually isolated with the finger or a director, working at first towards its upper part, and taking especial care not to open the capsule. In separating the gland, numerous dilated veins will be met with; they must be tied in two places and divided between. When the superior thyroid vessels are reached, they should be doubly ligatured *en masse* and divided between the ligatures. The upper part of the lobe can now be turned down and the rest of it freed from the underlying structures until the isthmus is reached. This must be isolated, tied in two places, and divided between the ligatures, and then the remainder of the gland must be isolated until the lower border is reached, when the inferior thyroid vessels can be dealt with, great care being taken not to include the recurrent laryngeal nerve in the ligature. If preferred, the inferior thyroid vessels may be first ligatured and the isthmus dealt with as the final stage of the operation. All bleeding points must now be secured, and a drainage tube having been inserted the wound is closed and dressed.

In cases of cystic goitre the cysts may be treated by tapping them and injecting a solution of iodine or iron and leaving the cannula *in situ* until suppuration is established. This plan of treatment is attended with some risk, either from accidentally tapping a vein, or from setting up too great a degree of inflammation, which may extend to neighbouring parts, and it is very uncertain. In cases where there is only a single cyst, it should be treated by enucleation, and in some cases this can be accomplished without much difficulty; in others there is often considerable hæmorrhage on attempting to enucleate, and under these circumstances the cyst should be laid freely open and stuffed with gauze. Where there are many cysts, removal of the affected lobe may be necessary.

The treatment of exophthalmic goitre consists chiefly in improving the patient's health by plenty of fresh air, gentle exercise, and careful diet. The patient should be freed, as far as possible, from all worry and emotional disturbance, and all hard work or anything which will produce fatigue avoided. Any menstrual irregularity should be corrected. Iron, especially in combination with strychnine, is very often useful, and recently thymus extract has been spoken of as producing good results. Of late years numerous cases have been recorded in which this condition has been treated by operative interference, either excision of the isthmus or more commonly removal of one lobe, and it is stated that good results have followed this proceeding. The dangers, however, attending operative interference are very great, for not only is the hæmorrhage often excessive, but patients have been known to die comatose within forty-eight hours after the operation; it is believed from excessive thyroid toxæmia. In addition to this, patients who are the subjects of exophthalmic goitre take anæsthetics very badly. The operation, therefore, ought not to be undertaken lightly or without the gravest consideration.

Jaboulay recommends in these cases division of the cervical sympathetics, and cases have been recorded of favourable results following this operation. A long incision is made down the posterior border of the sterno-mastoid; the muscle, with the internal jugular vein and common carotid artery, is drawn forward, the cord of the sympathetic exposed, and the middle cervical ganglion removed. The operation is repeated on the opposite side.

Acute goitre.—Goitre is usually a very chronic condition, the enlargement occurring very slowly and gradually, but it is necessary to mention that occasionally, especially in young children, the enlargement may be very rapid, and these cases are known as *acute goitre*. They are of especial interest because the enlargement is so rapid that the fasciæ of the neck have not time to stretch, and there is danger of asphyxia from pressure on the trachea. In these cases, should sudden dyspnœa set in, the surgeon must be prepared to perform tracheotomy. An incision must be made in the middle line, and the isthmus exposed. This should be divided between two ligatures and the trachea opened, a long tracheotomy tube being introduced, so as to extend beyond the level of the gland.

Inflammation of the thyroid.—This usually arises from the infection of pyæmia, but may also arise as the result of an injury. It is a rare condition, and generally occurs in those cases where the gland is already chronically enlarged. The **symptoms** are those of ordinary inflammation swelling of the gland, with acute pain, heat and redness of the skin over it. There is usually considerable constitutional disturbance, attended by a rigor when suppuration takes place, as it frequently does. The **treatment** in the early stage consists in keeping the patient in bed, hot fomentations, and careful dieting. If suppuration is suspected, an incision should be made. As this is often attended with very profuse hæmorrhage in those cases where the pus is deeply seated in the gland, after the superficial structures have been incised, the gland tissue should be perforated with a Paquelin's cautery.

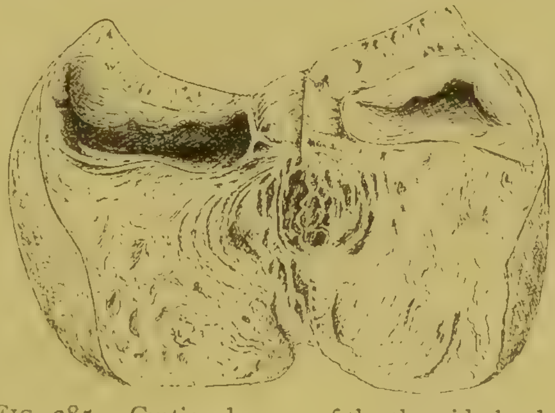

FIG. 285.—Cystic adenoma of the thyroid gland. (From the Museum of St. George's Hospital.)

Tumours of the thyroid (fig. 285).—A large number of cases of what was formerly regarded as parenchymatous enlargement of the thyroid body is now known to be adenomatous enlargement; that is to say, an adenomatous growth, starting in one part of the gland, which gradually spreads until it involves the whole organ; and this cannot be diagnosed until after removal from the parenchymatous enlargement. These tumours very often become cystic and then form a single cyst in the thyroid, as distinguished from the multiple cysts of the cystic bronchocele. These cysts have thick walls and contain a brown or chocolate-coloured fluid. The adenomata grow within the gland and bear the same relation to its structure as an adenoma of the breast does to the ordinary mammary tissue. They are circumscribed, and grow at the expense of the surrounding structures by causing atrophy from pressure.

The **treatment** consists in removal. An incision is made, the tumour is exposed, and can generally be easily shelled out from its connections.

Malignant tumours of the thyroid may be either carcinoma or sarcoma. Both varieties of growth are rare, but the former is the more common of the two, and starts from the epithelium of the acini of the gland, or from an embryonic epithelial mass, the *parathyroid*, which remains embryonic and never develops into true glandular structure. Malignant disease frequently develops in a gland which is already the seat of chronic enlargement. It grows rapidly and speedily infiltrates surrounding parts, the recurrent laryngeal nerves being especially early implicated in the growth. The tumour frequently invades the trachea, where it sprouts, producing symptoms of obstruction and expectoration of blood. The lymphatic glands are early infected, and secondary deposits soon take place, especially in the bones. The disease will be recognised by its rapid growth, by its implication of surrounding parts, by the loss of voice, and by the obstruction to the breathing and the hæmoptysis, which is often one of the first indications of the disease.

Treatment.—The treatment is excision, and this can only be done with any prospect of success in quite the early stage. If the surgeon can remove the whole gland before any part of the growth has perforated the capsule, and when there is no infection of the lymphatic glands, he may hope that there will be no recurrence; but as a rule, the growth is not diagnosed until it has implicated neighbouring parts, so that there are very few cases which are amenable to treatment.

CHAPTER XI

INJURIES AND DISEASES OF THE BACK

Contusions of the back are of common occurrence, and may be attended with large effusions of blood beneath the deep aponeurosis. They derive their importance from the fact that they may be complicated with injury to the spinal cord, and care should be taken to examine for numbness, tingling and formication, or interference with the functions of the bladder, before too confident a prognosis is given. Otherwise these bruises differ in no respect from contusions in other parts of the body.

The **symptoms** are pain and swelling of the injured parts, but often without visible ecchymosis, as the effused blood is beneath the deep fascia. There is great pain in moving and especially in extending the spine. Recovery is generally slow, and the extravasated blood may remain unabsorbed for a considerable period of time, forming a diffused swelling with a soft centre and hard margin. Occasionally in these cases the kidney may be contused and lacerated, and this will be indicated by the presence of blood in the water.

The **treatment** consists in keeping the patient at rest in bed, and if there is rapidly increasing effusion of blood, ice may be applied; otherwise hot fomentations or hot Goulard lotion with opium will be found to be most comforting to the patient. The rest should not be too prolonged, and when all acute symptoms have subsided, provided there is no evidence of any lesion of the cord, massage and methodical friction should be applied.

Sprains of the spine.—On account of the multiplicity of joints and the complicated system of muscles and ligaments, sprains of the spine are a form of injury which should never be regarded lightly, especially as the injury may be complicated with some lesion or subsequent inflammation of the delicate nervous structures contained within its bony walls. The injury is usually produced by indirect violence—some sudden and unexpected wrench, which produces violent twisting or bending of the whole column, and stretching or laceration of the muscles, fasciæ, or ligaments of the back. From this the patient may entirely recover, or persistent pain with rigidity may follow owing to adhesions having formed in the muscles and other soft parts which have been injured. In some cases graver results may follow: where the ligamenta subflava have been torn hæmorrhage may take place into the spinal canal; or where the meninges of the cord have been injured, inflammation of the membranes of the cord itself may be set up. Again, in other cases, disease of the bones of the spine may be caused by the injury, especially in the tuberculous child.

The **symptoms** are those of severe injury. The patient is considerably collapsed, and complains of great pain in the back; the lumbar region being the part which is generally most affected, and where therefore the pain is most acute. It is greatly increased by any attempt at movement; and the patient keeps his back rigid. There is usually swelling and there may be some bruising, but this does not, as a rule, occur till later. In investigating a case of sprained spine, care must be taken to ascertain that the spinal cord is not involved, and this will be indicated by some modification of sensation in the parts below, such as a feeling of 'pins and needles' or numbness, with or without paresis or paralysis. An important indication, and one which should never be lightly disregarded, is any interference in the power of the bladder to expel its contents.

Treatment.—In treating sprains of the back, the first indication is to keep the patient absolutely quiet in bed, until the pain and symptoms of active mischief have subsided. As soon as this is so, and the patient can move in bed, massage should be regularly employed. If this is thoroughly done, the painful fixed spine which occasionally follows these injuries will generally be avoided. The patient should be allowed to move about, and should be encouraged to flex and extend his spine. The treatment of those cases which are complicated with injury to the cord will be considered later on, since the treatment must of course be directed to this graver lesion.

Traumatic lumbago.—After a severe lumbar strain, the patient for some time may complain of great pain in the loins, especially on moving. This is accompanied by stiffness and rigidity, so that he carries his back in an unbending attitude; and superadded to these symptoms there may be difficulty in walking and interference with the natural acts of defæcation and micturition, and he presents a condition of pseudo-paralysis, which is simply due to stiffness and incapacity of the spinal muscles, so that they cannot act without pain and are unable to give support to the spine. This condition is known as *traumatic lumbago*, and may be mistaken for some injury to the cord itself. The treatment consists in systematic massage to the muscles of the back; the application of dry heat, by ironing the back every day with a heated flat iron, and encouraging the patient to move about and exercise his muscles. Sometimes considerable and immediate relief may be obtained by forcibly extending the spinal muscles under an anæsthetic. The thighs are first flexed to their fullest extent on the abdomen, and then the shoulders are raised from the bed, and the chest and head doubled forwards. Or the buttocks and lower part of the trunk may be raised, the shoulders being allowed to rest on the bed. This proceeding is most applicable to those cases where adhesions are believed to exist, matting together the muscles and soft structures of the spine.

Concussion of the spinal cord.—In rare instances a severe injury to the back is accompanied by a temporary interference with the functions of the cord, the symptoms coming on immediately on the receipt of the injury, and having a tendency to pass off rapidly and terminate in complete recovery. These cases are strictly analogous to cases of concussion of the brain, and should be regarded as cases of true concussion of the cord. They are extremely rare, but undoubtedly do occur.

The **symptoms** are as follows. After a severe injury to the back, as a blow from a heavy weight falling upon it, or a violent twist or wrench, the patient falls to the ground and is unable to rise. There is loss of power, more or less complete in the muscles supplied by nerves coming off below the seat of injury, and a feeling of numbness in these parts. Thus, if the injury is in the dorsi-lumbar region, as is most frequently the case, there will be more or less complete paraplegia, with loss of the reflexes and paralysis of the sphincters. The lower extremities feel cold and numb and sensation in them is impaired or lost. There is paralysis of the bladder, necessitating the use of a catheter. Accompanying these signs there is evidence of general shock ; the temperature is subnormal ; the pulse weak and rapid, and the respiration shallow. As the patient recovers from the shock, the symptoms pass off; he recovers his power of movement ; normal sensation returns, and he is again able to void his urine, and as a rule subsequent symptoms of secondary changes in the cord do not appear.

Bruising of the cord.—There is, however, a second class of cases, which in the first instance very much resemble those above alluded to, but in which the symptoms do not pass off so readily, but remain more or less persistent, and in which, though the patient may partially recover his powers of movement, he does not do so completely, but walks with a shuffling, unsteady gait, and complains of peculiar sensations, numbness, 'pins and needles,' or shooting pains in his legs. The power over his detrusor urinæ is also impaired, and he is often obliged to strain for a minute or two before he can void his urine. These cases are believed to be due to some minute hæmorrhages into the spinal cord or some slight extravasation into the theca, followed by secondary changes in the structure of the cord produced by this lesion.

In connection with this subject it ought to be mentioned that it is doubted by some whether cases of concussion ever occur in which the tissues of the spinal marrow or its vessels are uninjured. These surgeons believe that in every case there is some minute hæmorrhage into the delicate nervous substance or some extravasation of blood into the theca of the cord. If this is so, then the cases of transient paralysis, which rapidly clear up, are those in which the minute hæmorrhages are rapidly absorbed, while those in which the symptoms persist are cases where this absorption does not take place so rapidly, and in which there are probably secondary changes in the cord.

Treatment.—The treatment consists in keeping the patient absolutely at rest in the recumbent position and relieving his bladder at intervals if necessary. In the first class of cases this is all that is required. But if the symptoms do not pass off, more prolonged rest will be called for, and some surgeons recommend that the patient should be placed in the prone position, so as to prevent passive congestion. Dry cupping, the thermo-cautery, and flying blisters are often useful, and electricity should be employed for the purpose of maintaining the nutrition of the paralysed muscles.

Special injuries of railway collisions.—A class of cases which often follow railway accidents, but are in no wise peculiar to the effects of railway injuries, and occasionally occur after many other forms of injury, are often spoken of as *concussion of the spine*. The name is an unfortunate one, as it would seem to imply that there has been some injury to the spine which has produced a transient interference with its function, much in the same way as a blow on the head may produce a concussion of the brain. That this is not so is sufficiently obvious from the symptoms.

These cases, which are often popularly termed *railway spine*, would appear to be of two distinct kinds : one in which after a severe wrench or injury there follows a condition of nerve exhaustion, due to excessive irritability and weakness of the brain and spinal cord, without any lesion in these structures themselves; the other where the symptoms are probably due to chronic inflammatory changes in the cord.

1. Page, who has devoted a good deal of attention to this subject, is inclined to class all cases of so-called railway spine in the first group. He believes that the condition is produced by a wrench or strain, involving the muscles, ligaments, and other extra-spinal structures, accompanied by severe shock, terror, and mental derangement, the result of the circumstances of the accident in which the patient has been placed. As a consequence of the general violence, and also, more especially, of the alarming circumstances of the accident, a condition of nerve prostration or exhaustion (neurasthenia) is set up, which is often exaggerated by a considerable element of hysteria; and as an outcome of this there is nervousness, restlessness, and sleeplessness, with derangement of the circulatory and digestive organs. Moreover, the strain to the muscular and ligamentous structures of the back induces a stiffness and incapacity of the spinal muscles and ligaments, which are no longer able to support the spine, and cannot be called into action without pain. Thus a condition of pseudo-paralysis is set up because the patient is afraid to move his legs on account of the pain. By reason of the same muscular incapacity there may be difficulty in defæcation and micturition, or even retention of urine. In this way the symptoms which are present in the condition known as railway spine are set up.

The **symptoms** may come on immediately after the accident, the patient from the first lying helpless and prostrate; but more usually they appear after a variable lapse of time, during which, though he may have been occupied in his daily work, he has never felt perfectly well or completely restored from the effects of the injury. He has found that he cannot concentrate his attention or apply himself to work, that he has had constant headache and pain in the back. The incapacity of the muscles of the back and the pain on movement cause an inability to support the weight of the body and a difficulty in moving the legs. The patient complains and fully believes that he is unable to walk, and fears that he is about to become paralysed, more especially if there is retention of urine, or even difficulty in micturition. This produces a condition of mental despondency, and the nervousness and depression may be extreme. The countenance is pallid, worn, and anxious looking, and the thoughts are confused, and great fatigue and exhaustion are complained of after an attempt to perform any work either mental or physical. Palpitation is complained of, and there is often irregularity of the heart's action. The sleep is disturbed, and the patient dreams much, the dreams being usually of a distressing character. The patient is highly emotional, wont to burst out into fits of hysterical crying, and all these symptoms are aggravated by mental excitement. There are, in fact, a train of symptoms which point conclusively to a depression and lowering in tone of the nervous system.

The **prognosis** in these cases is generally favourable, the patient usually recovering after a period of rest and change of air; but in some cases recovery does not take place, the patient drifts into a chronic and often bedridden invalid, or he is carried off by some intercurrent disease.

Treatment.—The treatment consists in the early stage in rest, both mental and bodily, accompanied by healthy hygienic surroundings and careful dieting; but the rest must not be continued too long, and a good deal of discrimination is required in deciding when the patient should be encouraged to move about. The back should be massaged with stimulating liniments, and as soon as all pain and tenderness, especially pain on movement, has disappeared, the patient should be induced to get up and take exercise. He should have change of air and scene, and his mind should be drawn away from his condition as much as possible by cheerful society and surroundings. At this time the administration of iron and strychnia, and galvanism to the muscles of the back, is often productive of great good.

2. The second class of cases which have received the name of railway spine are happily much more uncommon. They are cases in which a condition of spinal meningitis or myelitis is set up as a result of the injury. It is of a very chronic nature, and leads to degenerative changes in the cord. This condition has been named by Erichsen *indirect concussion.* In these cases there is always a distinct period after the accident, sometimes weeks or months, during which the patient suffers from no definite symptoms, and during which he believes himself to have recovered from the accident. It may be that at the time of the injury there were no symptoms, or, if there were, they have passed off and left the patient presumably convalescent. But he is not quite well. There is a disinclination and inability to apply himself to any work. He looks wan and haggard, and loses flesh, and does not feel capable of making any exertion. He is not the man he was. Then insidious symptoms supervene. His brain power is diminished; he loses his memory and displays great irritability of temper. Various disturbances of the nervous system, not only of the spinal marrow, but also of the brain from ascending myelitis, begin to appear. The organs of special sense are affected; the vision is usually defective, or there may be asthenopia from want of power of accommodation, and the movements of the pupil are sluggish. The hearing may be partially lost, or, on the other hand, there may be oversensitiveness and complaints of all sorts of noises in the ears, and any sudden noise may be peculiarly distressing. Sensation is perverted; the patient complains of pins and needles in his legs, of numbness or sometimes of shooting pains down the limb. He will state that he feels as if he were treading on cotton wool when he puts his feet to the ground, and he will be unable to button his clothes or pick up a pin from the floor, because the sense of touch is perverted. There is loss of motor power, especially in the lower extremities, the patient walking with a tottering, unsteady gait, and requiring a stick or some article of furniture for his support. The tendon reflexes are generally exaggerated. He complains of inability to sleep; of distressing and horrifying dreams, and steadily loses weight. There is often dribbling of urine, the bladder is unable to retain its contents, and there is impairment or loss of sexual power. On examining the spine, one or more tender spots may be discovered by percussion, and there is more or less rigidity, which accounts for his unbending attitude.

The **prognosis** in those cases where the condition has come on gradually and is steadily progressing is not good, and the probabilities are that the patient will drift into a confirmed invalid and become permanently crippled. Yet many of these cases recover after a prolonged period of rest. Much will depend upon the general health and recuperative powers of the patient, and upon whether the disease has been recognised and treated in the early stage.

Treatment.—The treatment consists in the enforcement of absolute rest, preferably in the prone position, and the administration of mercury in small doses for a considerable period. The best form in which to administer this drug is the perchloride, and iodide of potassium may sometimes be advantageously given with it, so as to convert it into the biniodide. Counter irritation in the form of blisters, or, what is perhaps better, light touches with the actual cautery once or twice a week, is indicated. Later on the use of strychnia and galvanism, with massage to the limbs and douching with warm sea water, are beneficial, and the patient should be encouraged to take gentle exercise. The general health must be attended to and improved in every possible way, and change of air, especially to the seaside, may be advised.

Spinal hæmorrhage.—In addition to the cases which have been already alluded to, in which there may have been minute hæmorrhages into the cord, there are cases in which severe hæmorrhage may take place into the cord or its membranes as the result of injury without any serious damage to the spinal column. It is somewhat difficult to understand how such a serious injury as extravasation into the substance of the cord should occur without lesion to the bones, but it seems most probable that it is due to a sudden and acute bending of the cord at the time of injury, because the favourite seat for these extravasations is about the fourth, fifth, and sixth cervical vertebræ, where the amount of flexion is very considerable, and where the cervical curve with its convexity forwards is greatest. In those cases where the hæmorrhage takes place outside the cord into the membranes, the origin of the hæmorrhage is generally pretty definite. It usually comes from ruptured ligamenta subflava or from a limited fracture of the bones.

1. **Meningeal hæmorrhage.**—This is much the more common condition of the two, the blood being extravasated usually between the bone and the dura mater, but occasionally finding its way between the other membranes.

Symptoms.—In these cases the symptoms do not usually come on until after the lapse of an appreciable period from the time of the injury, the blood being slowly poured out and taking some time before it has accumulated in sufficient quantities to produce any definite pressure on the cord. There is a fixed pain in the back at the seat of injury, and, in addition to this, pain along the course of the nerves coming off from the part of the spine injured, since they are pressed upon by the extravasated blood. This is accompanied by hyperæsthesia or perverted sensation in the parts supplied by these nerves. Thus, for instance, where the injury has been in the dorsal region, a girdle pain around the thorax or abdomen may be complained of. There is also cramp or spasm in the muscles supplied by these compressed nerves, followed it may be by paresis or paralysis. If the amount of extravasation has been considerable, there may be numbness and loss of power in the parts below the seat of injury from direct pressure on the cord; and in some cases an ascending paralysis is set up from accumulation of blood in the spinal canal, collecting from below upwards, until death results from pressure on the upper cervical region of the cord. Conjoined with these symptoms there is an entire absence of any febrile condition, by which it must be diagnosed from spinal meningitis, to which it bears a considerable resemblance.

2. **Intra-spinal hæmorrhage.**—In those cases where the hæmorrhage takes place into the substance of the spinal cord, the extra-

vasation is generally distinctly localised and rarely exceeds an almond in size (fig. 286). It is most frequently situated in the cervical enlargement for the reason mentioned above.

In one class of cases the extravasation involves the whole section of the cord and completely destroys its function, and under these circumstances the symptoms are exactly analogous to those which would be produced by a transverse section of the cord in the same situation. The patient is suddenly struck down with paralysis and loss of sensation in all the parts supplied by nerves coming off below the seat of lesion. In other cases, where the extravasation is not so great and is confined to the grey matter, the conducting powers of the cord may not be completely destroyed, and there may not be complete paralysis and loss of sensation in all the parts supplied by nerves coming off below the injured part, but paralysis of single muscles or groups of muscles, with loss of sensation in localised definite areas. If the patient survives the injury for any length of time, secondary degenerative changes come on and run the ordinary course. When the injury is in the cervical enlargement, it may be immediately fatal from implication of the phrenic nerve, or death may ensue within a very short period of time from interference with the respiration.

Treatment.—Nothing much can be done for the treatment of cases where the hæmorrhage has taken place into the substance of the cord; the patient must be kept absolutely quiet, ice applied to the spine, and ergotine administered internally or injected subcutaneously; but where the hæmorrhage is meningeal and a diagnosis is made early, the question of laminectomy should always be seriously considered, especially in those cases where the pressure is sufficient to cause loss of power and sensation in the parts below, and above all in those cases in which there is any evidence of an ascending paralysis taking place. In the slighter cases rest and ice to the spine is all that is required, followed later on by counter irritation. In these cases the clot may become completely absorbed, and the patient restored to a condition of perfect health.

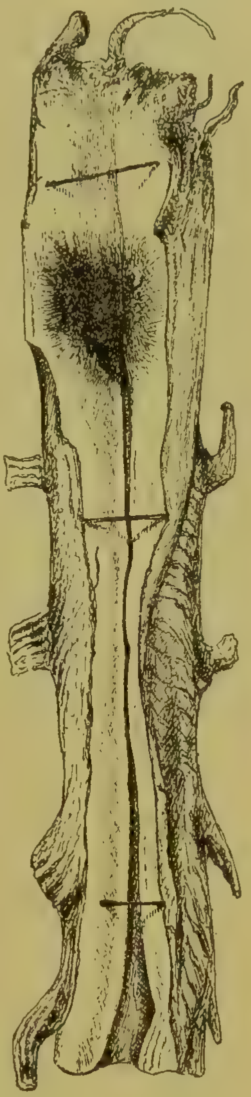

Fig. 286. — Extravasation of blood into the substance of the cord. (From the Museum of St. George's Hospital.)

Wounds of the spine.—Penetrating wounds of the spine are always grave injuries, but happily in civil practice are very uncommon. They may be due to gunshot wounds, to stabs with pointed instruments, when they are most likely to occur in the neck, where it is by no means difficult for a pointed instrument to penetrate between the laminæ of the vertebræ, whereas in the dorsal region the imbrication of the laminæ forms an efficient protection to the spinal canal, and in the lumbar region the depth of the spinal column from the surface of the body renders a punctured wound less liable to penetrate the canal. These wounds may also be caused by the body of the patient becoming impaled on area railings, projecting iron spikes or branches of trees, in falling from a height. In gunshot wounds they are generally complicated with fracture, and the bones of the spine may be extensively comminuted at the seat of impact, or may be simply perforated by a bullet travelling with great velocity. The spinal cord may be completely or partially severed, or may be crushed by detached fragments of bone. These injuries may be complicated with injury of other important structures, as the vertebral artery in the neck, and death may ensue from hæmorrhage; or one of the great vessels lying in close relationship with one of the other regions of the cord may be injured, and death result from the same cause; or one of the thoracic or abdominal viscera may be wounded. Punctured wounds from stabs, which penetrate the canal, may open it without wounding the membranes, or may penetrate the membranes without implicating the cord, or lastly may divide the cord either completely or partially.

Symptoms.—1. In those cases where the canal has been opened, but the membranes have not been penetrated, there would probably be no immediate symptoms beyond those due to the wound itself; but after a short interval symptoms due to hæmorrhage between the bone and dura mater might come on. Such cases as these would probably do well with careful attention to antiseptic principles.

2. In those cases where the membranes have been perforated, but the cord has not been injured, the diagnosis can only be made with certainty when there is escape of cerebro-spinal fluid from the wound. This, with a knowledge of the direction of the wound and the weapon that caused it, would be sufficient to enable one to make a diagnosis; but discharge of cerebro-spinal fluid does not take place in every case where the membranes have been penetrated, for the wound may be oblique or valvular, and thus prevent the escape of the fluid. Beyond the escape of cerebro-spinal fluid, there are no distinguishing signs of the injury, and it is only the advent of septic spinal meningitis, which is apt to supervene, that establishes the diagnosis.

3. In those cases where the cord itself is implicated, the wound may produce complete or partial division of this structure. When the cord is completely divided, there is paralysis of sensation and motion in all the parts supplied by nerves coming off from it below the point of division; the symptoms, therefore, will vary according to the situation at which the division takes place.

(1) If the division takes place above the fourth cervical vertebra—that is to say, above the origin of the phrenic nerves—instantaneous death is the result, from paralysis of the diaphragm and all the other inspiratory muscles.

(2) If the division takes place in the lower cervical region, there is paralysis of sensation and motion of the whole of the trunk and lower extremities, except the upper part of the front of the chest, where sensation is present, as this part is supplied by the descending branches of the superficial cervical plexus. There is also paralysis and loss of sensation in the whole of the upper extremity when the division is high up, and the whole of the brachial plexus involved; or partial paralysis and loss of sensation when the section is lower down, and the nerves forming the upper cords of the brachial plexus are not involved. The muscles which principally escape paralysis under these circumstances are some of

the scapular muscles, supra-spinatus, infra-spinatus, and teres minor, and some of the muscles of the arm, biceps, brachialis anticus, and deltoid. The breathing is entirely diaphragmatic, and the action of this muscle speedily becomes impaired, partly by the accumulation of gas and stagnant fæces in the intestines, and partly by the want of an opposing force to fix the lower ribs, so that when the diaphragm contracts it pulls them inwards, instead of by its contraction descending and increasing the size of the thoracic cavity. The lungs become congested and œdematous; the face suffused and purple, and the patient generally dies in from twenty-four to forty-eight hours.

(3) If the injury is situated in the cervico-dorsal region, above the level of the second or third dorsal vertebra, there is the same paralysis and loss of sensation of the trunk and lower extremities, but the upper extremities escape or present a condition of hyperæsthesia from irritation of that part of the spine from which the cords of the brachial plexus take origin. The whole of the intercostal and other muscles of inspiration are paralysed, with the exception of the diaphragm and a few accessory muscles in the neck. The muscles of expiration are all paralysed, and expiration is simply performed by the elastic recoil of the chest wall, and all forced expiratory efforts, such as coughing and sneezing, are impossible; the patient is therefore unable to expel any mucus from the lungs, and usually dies from asphyxia, partly due to this cause and partly to hypostatic pneumonia, in a few days.

(4) When the cord is divided in the mid-dorsal region, the organs of respiration are not so much involved, because the upper intercostal muscles and many of the forced muscles of inspiration are not paralysed, but the action of the diaphragm is still embarrassed by the want of fixity of the lower ribs. The abdominal muscles are also paralysed, so that the forced expiratory effort of coughing is embarrassed and hindered. A low form of pneumonia is therefore very liable to be set up, which often causes death in two or three weeks. There is loss of sensation of the abdominal wall, often limited above by an hyperæsthetic zone, so that the patient complains of a sensation like a cord tied round the waist (girdle pain). There is not usually retention of urine, except during the first few days, because the micturition centre in the cord is not interfered with; but when the bladder is full, the detrusor urinæ contracts from reflex irritation, and expels the urine; of course, without any voluntary effort or knowledge of the patient.

(5) When the division of the cord is in the dorsi-lumbar region, there is complete loss of sensation and motion in all the parts supplied by the lumbar and sacral plexuses. The whole of the lower extremity, the buttock, the perineum, and the hypogastric region of the abdomen, are devoid of sensation, and all the muscles of the lower extremity, including those which pass from the pelvis to the limb, are paralysed. The sphincter ani is also paralysed, and there is incontinence of flatus and fæces. The urine is retained and overflows, but there is usually no power of expelling it, as the micturition centres are involved in the injury; the urine therefore dribbles away as soon as the bladder becomes sufficiently full to overcome the slight mechanical resistance of the urethra, the walls of which in the natural condition of parts are in contact. The urine in these cases soon becomes ammoniacal from the introduction of bacteria, which travel down the mucus contained in the urethra, and which it is not able to expel, or they may be introduced with the catheter used to relieve the distension.

The alkaline urine sets up cystitis, and the inflammation spreads up the ureters to the kidneys, and causes septic nephritis, or septic poisoning may set in by absorption from the ulcerated coats of the bladder, the result of the inflammation. Bedsores are also very likely to occur, and the exhaustion they produce may be the cause of death. Priapism or semi-erection of the penis is a frequent accompaniment of complete division of the cord in any part above the site of the centre in which this condition is generated, but is perhaps most common when the injury is in the upper part of the cord. It is supposed to arise from the control of the centre having been cut off by the division of the cord above it.

(6) Division of the cauda equina low down, e.g. at the sacro-vertebral angle, is attended by loss of sensation and motion in the parts supplied by the sacral plexus only. Conjoined with this there is paralysis of the sphincter ani and incontinence of fæces, and paralysis of the detrusor and sphincter vesicæ, with retention of urine, followed by overflow.

In cases where there is a simple puncture or a partial division of the cord, the symptoms are not so definite or clearly marked. The extent of the injury will only be revealed by the resultant symptoms of nerve impairment; by paralysis or loss of sensation corresponding with the part that is involved. In cases where there is division of one lateral half of the cord, there would be, according to the most recent views, paralysis of both sensation and motion on the same side as that in which the section had been made.

Treatment.—The great aim in the treatment of penetrating wounds of the spine is to render the parts as aseptic as possible. In order to accomplish this end an anæsthetic should be given, and if necessary the external wound enlarged; all foreign bodies and loose pieces of bone should be removed, and the parts thoroughly cleansed with a strong antiseptic solution. If the dura mater has been severed and the cord not injured, an attempt should be made to accurately adjust the edges of the wound in the membrane, so as to prevent as far as possible the escape of cerebro-spinal fluid; a drainage tube must at the same time be inserted to carry off any fluid which may escape. The patient should be laid flat in bed, without any pillows, and preferably on his face. When the spinal cord has been injured, it is useless to make any attempt to suture it: a drainage tube should be inserted and the wound dressed. The great difficulty in dealing with penetrating wounds of the membranes is the escape of cerebro-spinal fluid, and it is a good plan to cover the wound with a bag of gauze which has been filled with boric acid powder; the fluid escapes into this, and its decomposition is prevented.

Spinal meningitis and myelitis.—These two conditions may be considered together, since they usually exist at the same time, or the one passes into the other. They are most commonly septic in their origin, arising in cases of penetrating wounds or after the bursting of a spina bifida, but they may arise where there is no wound in cases of crushing of the cord from displaced bone or contusion without fracture. They may present themselves either as an acute or chronic condition.

Acute meningitis and myelitis.—In the acute form the membranes become hyperæmic, and effusion of lymph takes place, which may eventually become pus. The cord becomes red and softened, and the nerve elements destroyed.

The **symptoms** are deep-seated pain in the back, increased by movement; rigidity of the spine; pain and hyperæsthesia of the parts below, and painful cramps and spasm of the muscles of the lower limbs. The reflexes are exaggerated. This is followed by paraplegia; retention of urine and septic cystitis; incontinence of fæces and the formation of bed-sores; and the patient generally dies of exhaustion or bladder troubles, or the inflammation, in septic cases, may spread to the membranes of the brain, and he may die of compression of the brain. The local symptoms are attended by a considerable amount of fever, often ushered in by a rigor and followed by rapid emaciation and exhaustion. In some cases the active symptoms subside, and the disease assumes a chronic form.

Chronic meningitis and myelitis may be the sequel of an acute attack or may originate as a chronic condition, probably in cases where there has been no external wound, but some bruising of the cord or its membranes. The disease is usually localised. Inflammatory lymph is poured out upon the cord and into its substance, glueing the two together and causing sclerosis of the cord.

The **symptoms** are persistent local pain and tenderness, increased by pressure or movement, rigidity of the back, cramps or spasms in the lower limbs, going on to paralysis, and hyperæsthesia and shooting pains in the parts below the seat of the inflammation. The reflexes are exaggerated.

The **treatment** in these cases is not satisfactory. In the acute septic form probably no treatment is of any avail. In the other acute cases, ice may be applied to the spine, and absolute rest and low diet enjoined. In the chronic form counter irritation to the spine, absolute rest, and the long-continued administration of mercury in small doses is to be recommended.

Fractures of the spine.—These injuries may be conveniently divided into two classes: (1) incomplete, where the continuity of the column is not interrupted; and (2) complete, where there is a solution of continuity of the column, which is now divided in two parts, and these may become displaced from one another. In cases where this displacement occurs, the name *fracture-dislocation* is given, and they are by far the most common and the most important form of fracture, since the displaced bone in the majority of cases presses upon and crushes the spine marrow, and produces a very serious and, in the majority of cases, fatal lesion.

Causes.—Fractures of the spine, like fractures elsewhere, may be the result of direct or indirect violence. Fractures by direct violence are not so common as the other form; they may be produced by severe blows on the back, or by falls across a beam or gunshot injuries. The indirect form of fracture is produced by over-flexion of the spinal column; it may thus be caused in hunting, by the individual being thrown over the horse's head; or in diving, by the head coming violently in contact with the bottom of the bath; or by over-extension, as when a man driving under an archway catches his forehead against the arch.

1. **Incomplete fractures** are usually fractures of the spinous processes and laminæ, though in rare instances a transverse process may be broken off or even a fissure of the body may take place.

The **symptoms** are pain in the part, increased on movement or on manipulation, irregularity in the line of the spinous processes, with increased mobility. In many cases crepitus can be obtained, but often there is very considerable extravasation and bruising in the soft parts over the injured bone, and then the signs above mentioned are obscured.

The **treatment** consists in keeping the patient at rest in bed until all pain has subsided and union may be assumed to have taken place.

2. **Complete fracture.**—In this variety of fracture the bodies of the vertebræ are implicated, and are often extensively comminuted, and loose fragments of bone may be driven into the canal and injure the cord. The broken fragments are often crushed together and impacted into each other. The laminæ and processes usually partake in the injury, and are often variously broken and comminuted. Sometimes the injury consists in a partial fracture of the body of a vertebra and the partial tearing of the intervertebral substance, and then the vertebra above is usually displaced forwards on the lower, so that the spinal cord is compressed, when it is injured, between the posterior margin of the body below and the laminæ of the vertebra above. Generally the vertebral body is irregularly broken and crushed, but the displacement is the same; the vertebræ above the injury being displaced forwards (fig. 287).

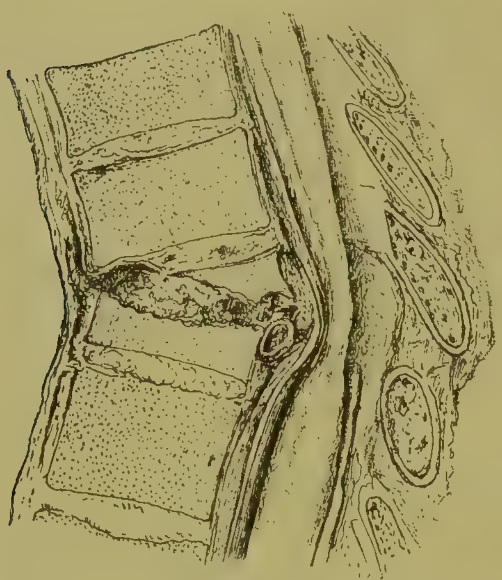

Fig. 287.—Fracture of the body of a vertebra, with displacement, crushing the cord. (From the Museum of St. George's Hospital.)

In those cases where the cord is crushed, it is generally completely disorganised at the seat of fracture, and symptoms are produced exactly resembling those which follow a transverse section of the cord, and these vary according to the region implicated (see page 748). When the displacement is not so great, the spinal cord is not so extensively injured, and under these circumstances there may be only partial paralysis of the parts below the injury: for example, there may be paralysis of one side of the body, below the lesion, when one half of the cord has been injured. In some cases there may be very considerable displacement, and still the cord may escape injury; and again, on the other hand, there may be complete disorganisation, where there has been little or no displacement. This may be due to hæmorrhage into its substance, or between the cord and its membranes, or to subsequent myelitis which has been set up by the injury to the bones and other structures.

Fracture-dislocation without injury to the cord.—These cases are very uncommon, but undoubtedly do occur. The symptoms produced are merely the local signs due to the injury and displacement of the bones. There is always a very considerable amount of shock, for the injury which will produce a fracture of the spine must be a severe one. There is pain at the seat of injury, which is greatly increased upon any movement or upon manipulating the parts. The patient is unable to maintain the body in the erect position or to sit up, and even turning in bed is impossible, and any attempt to do so attended with great pain. Upon examining the back there will be found to be considerable deformity, resembling an angular curvature of the spine, prominence of the spinous process of the vertebra below the fracture, and a hollow and absence of the spinous process above. There is often bruising of the soft parts around, and crepitus may be detected, but it is not wise to make any prolonged effort to elicit it. Accompanying these signs there is no evidence of any lesion of the spinal cord, or there may be a partial loss of power and sensation in the parts below owing to concussion of the cord, which passes off in a day or two.

Treatment.—In treating these cases no attempt should be made to reduce the deformity, since the effort to do so might produce such a change in the position of the bones as might lead to crushing of the cord. In other respects the case is to be treated exactly in the same way as fracture of any other bone, by keeping the parts at rest and immobile until union has taken place. This may be best done by placing the patient in a spinal jacket. A piece of poroplastic felt is to be shaped to the size of the patient, and having been heated and softened, he is gently raised, the felt slipped under him and then rapidly moulded to his body. When hard it can be retained in position by two or more webbings passed round the trunk. If preferred the jacket may be made of leather softened in vinegar and water, but it is not so firm as the felt. In this jacket the patient should be confined to bed for at least a couple of months, and may then be allowed to sit up for a short time, still wearing the jacket. There will of course always be some deformity.

Fracture-dislocation with injury to the cord.—In the great majority of cases in which fracture-dislocation takes place, the cord is injured by the displaced bone, and then, in addition to the signs which have been enumerated above, and which are due to the fracture and displacement of the bones, there are certain general symptoms which are dependent upon the injury which the cord has received. These are as follows : There is complete paralysis of motion and sensation in all the parts supplied with nerves derived from the cord below the seat of lesion. The amount of paralysis and loss of sensation will depend, therefore, upon the situation in which the fracture has occurred, and by considering the evel of the body to which the anæsthesia extends and the parts which are paralysed, the exact seat of the fracture can be defined. In some cases there is hyperæsthesia in the part just above those in which sensation is ost, depending either on irritation of the nerves as they leave the cord, or of the cord itself just above the disintegrated part. The reflexes are often altered ; those corresponding to the portion of the cord crushed are completely lost. Thus a fracture of the dorsi-lumbar spine may be attended with entire absence of knee jerk ; but the reflexes corresponding with portions of the spinal cord in the neighbourhood may be present or absent. It is said that when the fracture is due to indirect violence the reflexes are usually present ; but when it is due to direct violence they are often absent, because there is also concussion of the spine. Later on in he progress of the case the reflexes, whether present or absent in the earlier period, are present and much exaggerated, except those the centres of which are situated in the portion of the cord which has been destroyed. This is owing to the myelitis which has been set up. At the lower part of he lumbar region, where there is no special cord, but merely a leash of nerves, the cauda equina, some of the nerves may be torn, while others escape, so that the paralysis of the lower limbs may be confined to certain muscles, and the loss of sensation be only partial. There is paralysis of the sphincter ani, and the fæces are passed involuntarily and without the knowledge of the patient. This is especially so where the racture is low down in the dorsi-lumbar region, because the peristaltic movements of the intestine are not suspended, the sympathetic which supplies their muscular coat communicating with the cord at a higher level: when the fracture is higher up, the peristaltic motion is stopped and the fæces become arrested in the intestine. Owing to the loss of trophic influence in the rectum a low form of proctitis is liable to be set up, with the passage of tarry, liquid stools. The functions of the bladder are interfered with; if the injury to the cord is above the micturition centre the patient is able to expel his urine and does so by a reflex act and unconsciously, but if the micturition centre is involved in the injury the bladder is paralysed, the urine is retained and then overflows. Priapism is sometimes present, and is often excited by the passage of a catheter. The later symptoms of fracture are due to a low form of inflammation of the bladder and bedsore, and a fatal issue often ensues from toxæmia following septic cystitis or sloughing of the nates. The intellect is unaffected, and the patient is usually free from pain.

The **prognosis** depends upon the amount of injury which the cord has received and the situation where the injury has taken place. Where the paralysis and loss of sensation are absolute and persistent, and where therefore presumably the cord has been totally disintegrated, death in the great majority of cases occurs sooner or later; though cases have been recorded where there has been complete paralysis and loss of sensation from fracture in the dorsal and even the cervical region, and still the patients have lived for years (fig. 288). In cases of fracture in the dorsi-lumbar region this is not uncommon, but even in these cases death usually occurs eventually from some cause connected with the injury, as, for example, septic pyelonephritis set up by cystitis. The higher the fracture is, in most cases, the earlier does death occur.

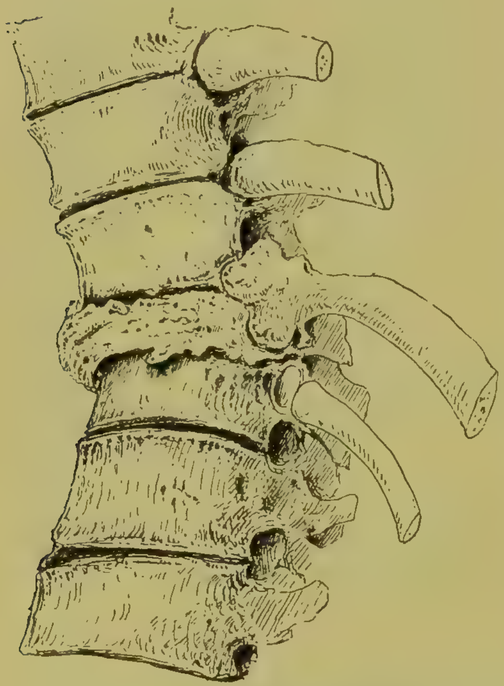
FIG. 288.—Bony union after fracture of the spine. (From the Museum of St. George's Hospital.)

Treatment.—The immediate treatment of a case of fracture-dislocation where the cord is crushed consists in rallying the patient from his collapse, and if thought desirable making an attempt to reduce the displacement. The patient is to be placed in bed, and all his clothes cut away without any rough handling or movement, and he is to be wrapped in a blanket. The head is to be kept low. Hot-water bottles may be placed in the bed, but must not be brought into contact with the anæsthetic skin, for fear of producing sloughing. A little hot tea or beef tea may be given, or if judged necessary a small quantity of hot brandy and water. The patient should be placed on a water bed. In many cases, if the fracture is comminuted and not impacted, the displacement disappears when the patient is laid flat on his back. When it does not, the question will have to be determined whether any attempt should be made to overcome it. In cases where the paralysis is complete, it would appear that there is very little to be gained by making any attempt at reduction, as the cord is in all probability crushed and irretrievably damaged ; but where the paralysis is incomplete, it may be right to attempt to reduce the deformity, especially in fractures of the dorsi-lumbar region. In fractures of the lower cervical and upper dorsal region the attempt is scarcely ever justifiable or likely to succeed. It must be remembered that the attempt cannot be made without running the risk of doing further mischief to the cord, and the proceedings must therefore be conducted with the greatest possible care. I have seen a dislocation between the last dorsal and first lumbar vertebra completely reduced by four dressers making gradual and steady extension from the shoulders and legs of the patient, but without any relief to the man's symptoms.

Another consideration which will have to occupy the surgeon's mind at this period of the case is whether any attempt should be made to relieve pressure by performing the operation of laminectomy. Considerable difference of opinion appears to exist among surgeons as to the desirability and value of this operation in these cases. The true state of the case appears to be as follows : where the cord is completely crushed and divided, there is no prospect of being able to do any good by the operation, and it is therefore unjustifiable and will probably only tend to hasten the patient's death ; but where the paralysis is incomplete or unsymmetrical, and there is reason therefore to believe that a portion of the cord is still intact, it may be possible, by performing a laminectomy, to relieve pressure and preserve a part of the cord, which has so far escaped, from subsequent destruction. Under these circumstances the operation would appear to be justifiable ; though it must be remembered that it is of a very serious nature, requiring a long and deep incision through a mass of muscles, and thus exhausting the patient's strength, when the object of the surgeon should be to support it as much as possible.

The subsequent treatment must be conducted with a view to combating the two main dangers of life : the tendency to the formation of bedsores, and the supervention of cystitis. With regard to the former, much will depend upon skilful nursing ; though even the most careful nurse cannot always prevent the formation of bedsores in these cases, for they may form not only on parts exposed to pressure, but also in places where there seems to be no pressure exerted, especially over prominences of bone, e.g. the anterior superior spine of the ilium and the malleoli, probably from the fact that these parts have been deprived of their nervous influence. Still, much may be done by careful nursing, for urine and fæces left in the bed, or any ruck in the sheet, or breadcrumbs irritate the skin and tend to produce sores. Scrupulous cleanliness is therefore necessary. Frequent slight changes in position are desirable in order to relieve pressure, and this may be done by gently rolling the patient to one side or the other and propping him up with pillows. But as this necessitates a little movement and might tend to alter the position of the injured parts, it is desirable to give support to the spine by moulding a leather or poro-plastic jacket to the back. Every precaution should be taken to prevent the supervention of cystitis. The bladder must be emptied every six or eight hours with a Jaques' catheter ; no metal instrument or instrument with a stylet should be used, as the urethra is insensible to pain, and damage may easily be done to it by a rigid instrument. Great care must be taken to prevent the admission of septic germs by the catheter. It should be carefully washed after use, and before being employed should be immersed in a solution of carbolic acid and lubricated with Lund's oil (olive oil, parts xv; castor oil, parts iv; carbolic acid, part j). After the catheter has been removed, the penis should be sluiced with a little corrosive sublimate solution and wrapped in antiseptic gauze, so as to prevent the passage of any micro-organisms down the mucus retained in the urethra. Should cystitis supervene, the bladder must be washed out every time the catheter is passed with an antiseptic solution. Permanganate of potash (ʒj to Oj) or boro-glyceride (ʒij to Oj) is a useful solution in these cases. The bowels are often obstinately constipated, especially where the fracture is high up, and relief must be afforded by purgatives (of which castor oil is the most efficient) and enemata. Occasionally, where the fracture is in the dorsi-lumbar region, there is diarrhœa, with the passage of tarry stools. These are the cases which try the skill and patience of the nurse. The diarrhœa is best combated by the injection into the rectum of laudanum in starch water. The patient's diet must be nourishing, but bland and easily digestible.

If attention is paid to these points the patient may live for a considerable time, even for years, and in some cases where the fracture is low down he may gain a certain amount of movement in the paralysed parts, but more often he succumbs eventually to septic troubles or exhaustion.

Dislocations.—Dislocation, independently of fracture, rarely, if ever, occurs in any part of the spine except the cervical region; and cases of so-called dislocation, in the vast majority of cases, belong to the class of fracture-dislocation of which we have just been speaking, and they require no further description here. It is, however, necessary to say a word or two on the subject of true dislocations, without fracture, which occur in the cervical region.

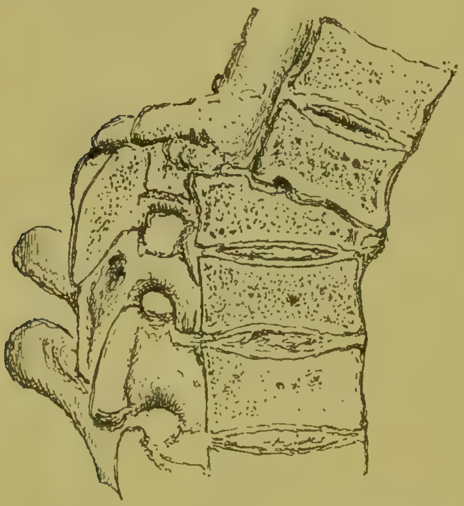

Fig. 289.—Dislocation between the fifth and sixth cervical vertebræ. (From the Museum of St. George's Hospital.)

Dislocation of the cervical vertebræ may occur between any of these bones, but most commonly takes place between the atlas and axis and between the fifth and sixth cervical vertebræ (fig. 289). It sometimes occurs between the atlas and occipital bone, and still more rarely between the other vertebræ of this region. The reason why displacement, without fracture, can take place in this region is partly due no doubt to the mobility and freedom of movement between the vertebral bodies and their small size, but mainly to the direction of their articular processes, which from their oblique direction permit them to slip over each other in a manner which is not easy in other regions of the spine. The upper fragment is in nearly every case displaced forwards, and the dislocation may be complete or incomplete or unilateral—that is to say, dislocation of the articular processes on one side only.

Causes.—Dislocation of the cervical vertebræ is most frequently caused by forcible flexion or twisting of the neck, as in judicial hanging, but may occur also from violent blows. Dislocation between the atlas and axis has taken place, with tearing of the transverse ligament, by lifting a struggling child by the head.

Complete dislocation.—In the complete form of dislocation there is always pressure on the cord, and the symptoms are the same as those of fracture-dislocation at the same level; dislocation affecting the first or second vertebræ being immediately fatal; while dislocation below the fourth is followed by death, usually within forty-eight hours.

In **incomplete dislocation** the symptoms vary with the amount of displacement. In some cases the cord may escape without injury, owing to the large size of the canal in this region; or it may be slightly bruised, when the paralysis is incomplete at first, but usually becomes complete later on from hæmorrhage into the canal or inflammatory changes in the cord. There is rigidity of the neck, and pain, increased on movement; irregularity will be felt in the line of the spinous processes and of the transverse processes, if they can be made out, which is not always possible. In these cases an attempt should be made to effect reduction. The surgeon standing behind the patient, who is laid on a table or bed, seizes the head and makes steady traction, and at the same time moves the head laterally, first to one side and then the other. If reduction cannot be effected by these means, the spinal column should be exposed by an incision in the middle line at the back of the neck, and the bones levered into their place. Occasionally it may be found that the impediment to reduction is the interlocking of the articular processes, and the removal of a small portion of one of them may facilitate reduction. The patient should be required, after reduction, to wear some sort of support in the shape of a moulded leather collar, which will fix the head on the shoulders for some months until perfect consolidation has taken place.

Unilateral dislocation.—In these cases the articular processes on one side of the body only are displaced from each other, with partial or complete tearing of the intervertebral disc. It may be produced by blows or falls on the side of the head. The head is fixed and turned to the opposite side to that on which the injury is situated; all movement is painful, and there is often radiating pain complained of in the nerve which is stretched as it passes through the intervertebral foramen. Upon examination it will be found that the spinous processes and the transverse processes, if they can be made out, are irregular. There are no signs of compression of the cord at first, though they may appear later from hæmorrhage into the canal, or from myelitis.

The **treatment** in these cases consists in making an attempt to reduce the displacement. The patient is anæsthetised, and by methodical movements the head is flexed and extended, or moved from side to side at the same time that a moderate degree of extension is kept up. The bone will sometimes be felt to slip into its place with an audible snap. If the surgeon fail to reduce the dislocation the bones become fixed in their new position, and an unsightly form of wry-neck, often accompanied by severe neuralgic pain, is set up. It is justifiable therefore in these cases to expose the parts by an incision, and endeavour in this way to correct the displacement.

Dislocation of the coccyx.—In connection with injuries of the spine must be mentioned a not very uncommon accident, in which the coccyx is displaced forwards by kicks or blows upon it, or falls on some hard projecting substance. The accident is accompanied by very severe pain and bruising, the pain being especially great upon the patient attempting to sit down or pass a motion. The diagnosis can be at once made by introducing the finger into the rectum, and the bone can usually be replaced without much difficulty. The displacement has, however, a tendency to recur, but this may sometimes be prevented by introducing a large plug of wool in the rectum and retaining it there for a week or so, during which time the bowels are kept from acting by opium. Should recurrence of displacement occur in spite of this, the bone should be cut down upon by a median posterior incision and removed. In some cases persistent pain in the part follows the injury, even when no recurrent displacement occurs; under these circumstances also, the bone may be removed.

DISEASES OF THE SPINE

Spina bifida is a congenital malformation due to the absence of one or more of the spines and neural arches of the spinal canal, and generally attended with the protrusion of the membranes, and generally the cord, through the gap which is thus left. Cases have been recorded where there has been a protrusion in front, through an hiatus left from defective development in the bodies of the vertebræ; but these are mere pathological curiosities, and need not occupy our attention further.

Etiology.—The condition arises, like so many other congenital malformations, from an arrest in development; from a failure in the process by which the medullary arches of the embryo, growing up on either side of the primitive groove, fuse together and enclose a canal, which is the future central canal of the cord, and from the walls of which the spinal cord and its membranes are developed. As this fusion of the medullary arches takes place from above downwards, the cleft in the spinal canal is usually situated at the lower part; and spina bifida is most common in the lumbo-sacral region, but may occur elsewhere, as in the dorsal region, or the whole, or nearly the whole, of the spinal canal may remain open.

Four different varieties of spina bifida are described: (1) meningocele; (2) meningo-myelocele; (3) syringo-myelocele; (4) spina bifida occulta. But in addition to these it must be mentioned that cases are met with where there is an entire absence of all attempt to form the medullary arches, and at birth the primitive groove may be seen patent, covered by nerve tissue, which is the spinal cord developed from the epiblast and spread out over its surface. To this condition the somewhat inappropriate term of *myelocele* has been given. It is incompatible with life, and therefore requires no further description.

(1) **Meningocele.**—In this form the dura mater and arachnoid membranes only are protruded through the gap in the bones, the cord, or cauda equina, remaining in its normal position. The herniated sac or bag thus protruded outside the spinal canal contains cerebro-spinal fluid, and freely communicates with the sub-arachnoid space. This is not a common form of spina bifida. Of the 125 cases examined by the Committee of the Clinical Society, ten only were of this variety.

(2) **Meningo-myelocele.**—This is the most common form of spina bifida. Of the 125 cases, 76 were of this variety. It consists of a protrusion, not only of the membranes, but of the cord itself (fig. 290). The filum terminale of the cord is attached to the inner surface of the

posterior wall of the sac, and there is usually a dimple of the skin corresponding to its point of attachment. The nerves of the cauda equina spread out over the surface of the sac, and perforate in to reach the intervertebral foramina. It occurs only in the lumbo-sacral region.

(3) **Syringo-myelocele.**—This condition is very rare; two only of the 125 cases being undoubted examples of this variety. In these cases the central canal of the cord is dilated; and the wall of the sac consists, therefore, not only of the membranes, but of a thin layer of nervous matter, which is the attenuated spinal cord, pressed against the membranes of the sac, but separated from it by the nerves arising from the nervous layer.

(4) **Spina bifida occulta.** In this form there is no protrusion. It will be considered after the symptoms and treatment of the other three have been described.

Symptoms.—The symptoms are those of a tumour, which is ovoid in shape, its long diameter corresponding with the axis of the spine. It is congenital, situated in the middle line and most usually in the lumbo-sacral region. It may vary much in size, being in some cases no larger than a plum, at others as big as the fœtal head. It is usually sessile, but generally has a somewhat constricted base; in some cases it is distinctly pedunculated.

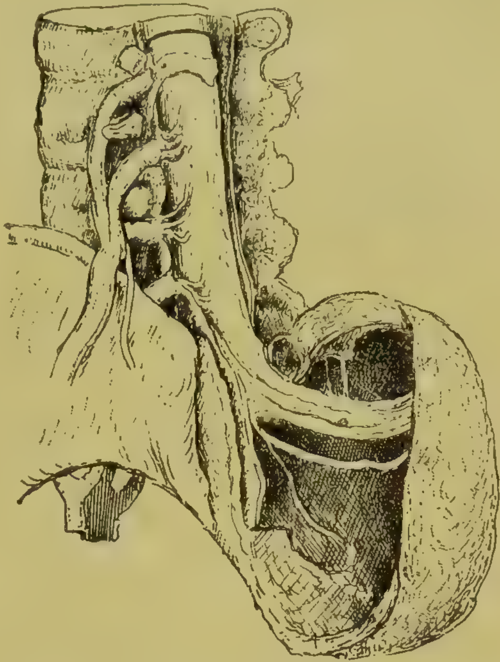

Fig. 290.—Spina bifida (meningo-myelocele). (From the Museum of St. George's Hospital.)

The consistence of the tumour varies. When the child is lying down it is usually soft and fluctuating, but upon putting it into the erect position the tumour becomes harder and tenser. It is also made more tense by expiratory efforts, as coughing or crying, and an impulse can be felt. It is translucent to light in the majority of cases, and in meningo-myelocele the nerves can sometimes be seen in the sac. It can be partially emptied by pressure, and if this is done in an infant, the fontanelle bulges and the child may become drowsy; when the fluid is expressed, the margin of the opening in the bone can usually be felt. The skin over the tumour is rarely normal throughout; its summit is usually covered by a thin, white, glistening membrane-like tissue. Frequently it presents a longitudinal furrow or a depression; this is indicative of the fact that the tumour is a meningo-myelocele.

It is not always possible to diagnose between these three forms of spina bifida. If the tumour is covered by healthy skin and is pedunculated, it is probably meningocele; if it is covered by thin cicatricial-looking tissue, and is furrowed or dimpled, it is probably meningo-myelocele, and the nerves may be seen in the sac by transmitted light. The rare form of syringo-myelocele cannot be diagnosed.

In spina bifida other deformities may be present, such as talipes or hare-lip; or it may be associated with other abnormalities, a stunted condition of the lower limbs, paralysis, and, it may be, hydrocephalus.

Prognosis.—The prognosis in spina bifida is not good. There is in a large proportion of cases a tendency for the sac to increase and finally rupture, causing death from spinal meningitis, or exhaustion from continual draining away of the fluid. Death may also take place from convulsions. In some few cases, however, the tumour ceases to grow, and may even shrink and become solid; or, where it is pedunculated, the communication with the spinal canal may become closed. The larger the tumour and the higher up it is situated, the graver will be the condition of the patient.

Treatment.—The treatment of spina bifida depends mainly upon whether the tumour is increasing in size. Where there is little or no tendency to increase, the cases are best left alone; the tumour being guarded by a carefully moulded metal or gutta-percha cap, which protects it, and making a certain amount of equable pressure upon it, may prevent its increase. If the sac is gradually increasing in size, and there seems reason to believe that it will eventually burst, then more active measures must be taken. Favourable results in some cases follow the injection of Morton's fluid, which consists of ten grains of iodine, half a drachm of iodide of potassium, and an ounce of glycerine. The object of the glycerine is to prevent a too rapid diffusion of the fluid. The child is laid on its side, and a small sterilised trocar and cannula is entered obliquely through the healthy skin at one side of the tumour. A small quantity of the cerebro-spinal fluid is withdrawn, and not more than a drachm of Morton's fluid is injected with a syringe, the nozzle of which accurately fits the cannula. The fluid is allowed to remain in, the cannula is withdrawn, and the puncture sealed. The injection has usually to be repeated at intervals of a week or ten days, and is sometimes followed by persistent leakage.

Excision of the sac has of late years been advocated. It is principally applicable to children who have survived at least a year since birth, in whom there is threatened rupture, and in whom there is no tendency to hydrocephalus. The operation is performed by raising the child's buttocks to a higher level than the head, and making an incision vertically over the tumour in the middle line, or, if the tumour is large and the skin in the middle line unhealthy, a semi-elliptical incision on either side. Skin-flaps are raised from the sides of the tumour and the neck of the sac exposed. If the case is one of meningocele, the neck of the sac must be ligatured if small, or sutured if large, and the sac cut away. If the case is one of meningo-myelocele, the sac must be opened and 'all portions of it which are free from nerve tissue excised, while the remainder is cut into ribbons, by incisions made from the interior, parallel with the nerves incorporated with it and thoroughly roughened with the point of the knife. The slashed and roughened sac is then placed in the patent spinal canal.' (Nicoll.) The edges of the wound in the membranes are accurately sutured with fine intestine silk. The muscles of the spine are brought together with buried suture, and finally the skin and subcutaneous tissues are sutured. The strictest asepsis is required, as primary union is essential.

The child, after the operation, should be kept with the head low, and if any leakage of cerebro-spinal fluid takes place, the wound should be covered with a bag of gauze containing boric acid powder, into which the fluid may drain.

This operation has been ably advocated by Mr. Mayo Robson, of Leeds. He states that the operation is indicated (1) in cases of meningocele, whether the opening into the canal is large or small; (2) in cases where the coverings are thin and translucent, even when this condition extends to the margin of the tumour; and (3) in cases where the cord is expanded, or nerves are blended with the sac. Excision of redundant parts, or incisions between manifest portions of nervous structure, reduces the tumour and enables it to be returned in the canal, and no difficulty is experienced in covering the replaced structures.

Professor Yelverton Pearson, of Cork, has introduced some modifications in the technique of the operation. He places the child on the side with the head low; he makes a lateral incision instead of a median one, and after incising the sac, plugs the canal with sponges to prevent leakage. After opening the sac, he retains the fluid, as far as possible, by holding up the margins of the opening with compression forceps, so that the contents of the sac are displayed in a bath of fluid, during the separation of the cord &c. from the skin; and finally he employs a small drainage tube for a few days, placed between the dura mater and the aponeurotic coverings.

Spina bifida occulta is a term applied to a condition where there is a deficiency of the laminæ and spinous processes of the lower vertebræ, and a hollow cul-de-sac of dura mater protruding through it and adherent to the skin, but without any visible swelling or tumour. The condition is indicated by the growth of a tuft of hair in the situation of the deficiency, which is sometimes of extraordinary length. In some cases a considerable deposit of fat takes place around the process of dura mater, presenting the appearance of an ordinary lipoma. This condition is often accompanied by imperfect innervation of the parts below; perforating ulcer, club foot, paralysis, and incontinence of urine have all been noted as complications of this disease.

Treatment.—When spina bifida occulta is uncomplicated, it is best to leave it alone; but where any of the above-mentioned complications exist, it should be treated by excision. The cul-de-sac should be exposed, ligatured at its base, and the distal portion removed. If this is done in early life, there may be some prospect of relief to the paralytic symptoms.

Sacro-coccygeal tumours. — There is a group of tumours occasionally found in the sacro-coccygeal region which is for the most part congenital, and which are known as congenital sacro-coccygeal tumours. They may be conveniently arranged in three groups: 1. **Dermoid tumours.**—These may be either cystic tumours, containing the ordinary dermoid structures, hair, epithelium, and sebaceous material; or more solid tumours resembling closely in structure the thyroid gland, consisting of alveoli, lined by cubical epithelium and bound together by connective tissue. These tumours spring from the structures between the rectum and coccyx, and are believed to be formed in connection with the mesenteric canal, by which, in the embryo, the neural canal communicates with the hind gut (see page 230). 2. **Teratomatous tumours,** which in their most highly developed form are included fœtuses, but more commonly cysts containing clear fluid with irregular masses of tissue in which fœtal remains are found. 3. Certain forms of tumour, cystic hygroma, lipoma, and soft fibromata, usually growing from the anterior surface of the sacrum and coccyx.

The **symptoms** differ with the nature of the tumour. They vary in consistence, and are often irregular on their surface. Their origin from the front of the sacrum and coccyx can usually be made out by a bimanual examination through the rectum and abdomen. Sometimes they attain a large size and fill the pelvis; and frequently they are not recognised for years until, in consequence of their size, they give rise to symptoms. They may press on the rectum and cause obstruction, or they may press on the ureters and cause dilatation of the ureters and hydro-nephrosis. The main indication as regards treatment is to remove them if possible; but in attempting removal it must be borne in mind that their attachments extend much more deeply than would be supposed upon a superficial examination.

Caries of the spine (*Pott's disease; angular curvature*).—The above names are given to a disease which is tuberculous in its nature, and is popularly known under the name of *disease of the spine*. This disease, like other tuberculous affections, occurs most frequently in children or young adults, but may arise at any age. It commences in the bodies of the vertebræ and gradually destroys them and the intervertebral substances, and sometimes causes a very considerable deformity, from the subsidence of the vertebræ above the diseased area on to those below; this is known under the name of *angular curvature*, in contradistinction to another deformity of the spine arising from very different causes, which is termed *lateral curvature*, and which will be described hereafter. Any part of the spine may be involved, but the disease is most commonly met with in the lower dorsal region.

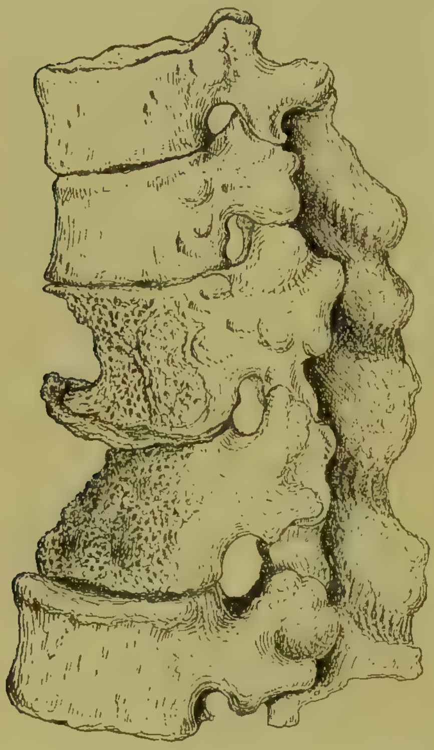

FIG. 291.—Caries of the spine. (From the Museum of St. George's Hospital.)

Etiology.—The cause of the disease is generally some slight injury or strain in a tuberculous individual, so slight that in a healthy subject it would be disregarded, or at the most would be recovered from in a few days; but in an individual who has either inherited a tuberculous taint, or acquired it from unhealthy hygienic surroundings or impairment of the general health, is sufficient to produce such a deterioration in the injured tissues as to render them a suitable nidus in which the tuberculous bacillus can grow and flourish.

Pathology.—The disease usually commences in children in the growing tissue of the body of the vertebræ in the neighbourhood of the epiphysial cartilages. This is the most vascular part of the bone where active changes are going on, and where, therefore, diseased processes are more readily set up. In the adult the more usual place for the commencement of the disease would appear to be in the deeper layers of the periosteum covering the anterior surfaces of the bodies of the vertebræ (fig. 291). In one or other of these places, deterioration of tissue having taken place, the bacillus finds a home, and changes take place which are identical in character with tuberculous disease in cancellous bone elsewhere (page 468). Granulation tissue is formed which gradually destroys and replaces the bone and intervertebral substance. The process may spread from bone to bone until the bodies of several vertebræ are involved; or it may be confined to one or two vertebræ; or in some cases more than one focus of disease may appear at the same time and produce carious cavities or worm-eaten surfaces in the bodies of several of the vertebræ, without any general coalescence of these cavities and extensive destruction of the bone. As the body of the vertebra is destroyed and is replaced by granulation, the weight of the head and trunk above the diseased part causes the superimposed vertebræ to sink downwards on to the healthy bone below; but as the arches and laminæ of the vertebræ are not involved, there is no sinking of the vertebræ as a whole, so that the approximation of the bodies causes an inclination forwards of the spine above the disease, and the condition of angular curvature is set up. This will perhaps be better understood by a reference to the accompanying figure (fig. 292). The fate of the granulation tissue varies. In some cases where recovery takes place, the greater part of the granulation tissue which has replaced the bone is absorbed without undergoing any degenerative changes, and the form of caries known as *caries sicca* is said to have taken place. But all of the granulation tissue is not absorbed; some part of it, and especially that which fills in the interstices between the displaced vertebræ and also the angle which has been formed in front of the vertebræ (see fig. 292, C), undergoes developmental processes and becomes converted into fibrous tissue, and then into bone, so that the displaced bones become welded together in their new position by osseous matter formed from the granulation tissue. In other cases the granulation tissue undergoes degenerative

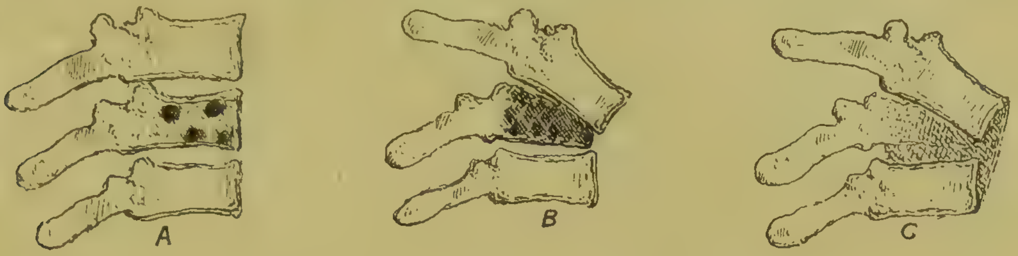

FIG. 292.—Diagram illustrating the manner in which the deformity takes place in caries of the spine, and the process by which it is repaired. A, Four caseating foci in the body of the vertebra. B, Further destruction and sinking of the body of the vertebra above. C, Repair; the space between the bodies of the two vertebræ and the angle in front is filled up with new bone.

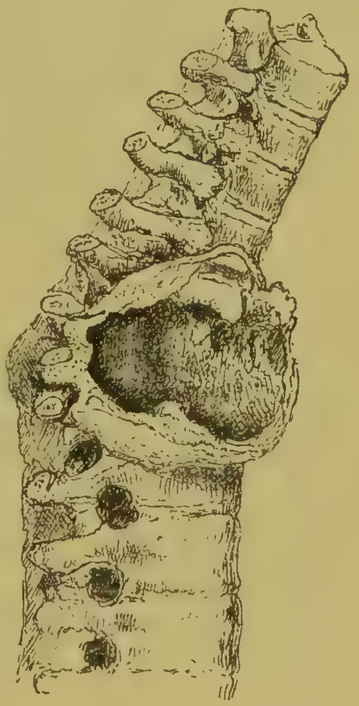

FIG. 293.—Caries, with abscess, of the spine. (From the Museum of St. George's Hospital.)

processes; it caseates, liquefies and forms a curdy fluid. In this way a chronic abscess is formed at the seat of the disease (fig. 293), which gradually tracks its way to the surface, often by a very circuitous route. But even in these cases recovery may take place. After the curdy material has been got rid of, or has dried up and formed an inert cretaceous mass, the granulation tissue which lines the cavity left between the bones, and which on account of its being nearer the source of nutritive supply does not disintegrate, undergoes developmental processes, and, as in the other case, becomes converted into bone and firmly ankyloses the bodies of the vertebræ together (fig. 294). Still a third change may take place. In some cases the granulation tissue undergoes caseation and degenerates before the osteoclasts have had time to absorb the bone. Under these circumstances, *necrotic caries* is said to occur, and we find in the cavity of the chronic abscess pieces of necrosed cancellous bone, often of considerable size. This is an important point, since the removal of these pieces of necrosed bone is often the first step to recovery, which cannot take place as long as they remain as sources of irritation.

The subsidence of the body of one vertebra on another is a very gradual process, and is rarely attended by any injury or pressure on the cord; but in some instances the inflammation in the bodies of the vertebræ may extend backwards through the posterior common ligament to the membranes of the cord, and symptoms of spinal irritation and paralysis may originate in this way.

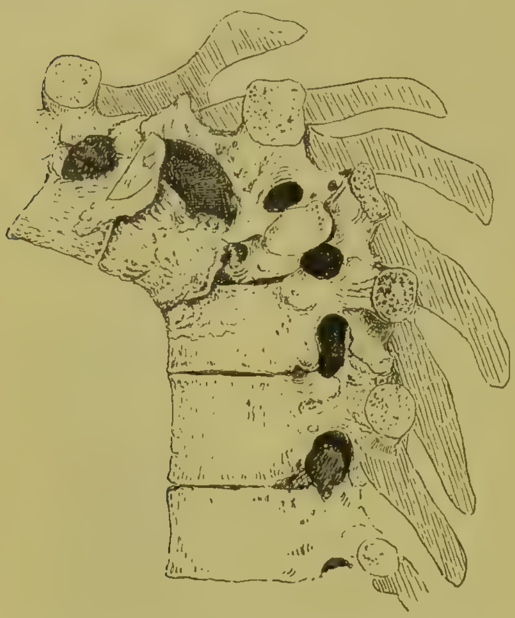

FIG. 294.—Extensive angular curvature of the spine, in which a cure has been effected and the remains of the diseased vertebræ ankylosed together. (From the Museum of St. George's Hospital.)

Symptoms.—It is of the utmost importance that this condition of tuberculous caries of the spine should be recognised early, before any displacement of the bones has taken place; for, if this is done, there is a very fair prospect that, by judicious treatment carried out for a sufficiently long time, recovery may take place without any deformity. We shall therefore discuss first of all the symptoms of this disease in its earliest stage, reserving for future consideration the symptoms arising from deformity, the formation of chronic abscess, and from spinal irritation or pressure.

The symptoms of tuberculous disease of the spine in its earliest stage may be considered under two heads, pain and rigidity.

Pain is a constant and important sign of disease of the spine, and is of two kinds: referred pain and local pain. 1. *Referred pain* is caused by the irritation of the nerves as they pass out through the intervertebral foramina, and is referred to their peripheral terminations. Thus if the disease is situated in the lower dorsal region, which it very commonly is, some of the lower dorsal nerves which supply the skin of the abdominal wall may be implicated, and pain in this region may be the result. A child therefore who is brought by its mother, complaining of 'belly ache' for which there is no obvious cause, should always be looked upon with suspicion, and a careful examination of the spine made. Sometimes a single nerve only is implicated, and this may produce a sensation as if a string were tied tightly round the body. This is popularly known as *girdle pain*. 2. *Local pain*, that is, pain at the seat of disease. The patient may come complaining of a fixed pain in one particular spot along the spine, but usually there is no pain, unless it is elicited by pressure on or percussion of the vertebral spines. If the spines are percussed one after another down the whole series, the patient will flinch and complain of pain when the spine of the diseased vertebra is struck; or a similar result can perhaps more readily be obtained by striking the transverse processes. Pain can also be usually elicited by jarring the spine, by causing the patient to jump off a footstool or low chair, or by requesting him to stand on tip-toe and then sharply bring his heels to the ground.

Rigidity is a constant sign of early disease of the spine, and is caused by reflex spasm of the muscles, which are thrown into contraction in order to immobilise the spine and prevent any movement of the diseased surfaces on each other. This rigidity causes the spine to be held in a stiff and erect position, and the patient walks with great caution. This rigid spine is often at once apparent to the practised eye, and causes the diagnosis in some cases to be made at a glance. But if it is not so apparent, the rigidity may be often demonstrated with great facility: if the patient is requested to flex the spine it will be at once seen that no movement takes place between the affected vertebræ; if he is asked to pick up any object from the floor, instead of bending the trunk to do so, he will flex the knees and hips, keeping the trunk rigid, or else go down on his knees in order to pick it up. The manner in which children recover themselves after stooping to pick up anything is often very characteristic. They will place their hands on their knees, and by gradually raising their hands up their thighs, assist the elevation of the trunk, by 'climbing up their legs,' as it is generally described. If the disease is in the cervical region the child will carry the head stiffly; the chin is poked forwards and often supported with one hand, and if the child is asked to look to one side he will turn the shoulders and trunk and not the head only. If then a child of a tuberculous type or with a tuberculous history is brought to a surgeon with a fixed and rigid spine, complaining of ill-defined superficial pains about the trunk, and a sensation of pain can be elicited by jarring the spine or percussing, there need be no hesitation in pronouncing the case to be one of tuberculous caries of the spine.

Deformity.—Sooner or later, if the case is not treated, deformity sets in, and corresponds in a great measure with the extent to which the bodies of the vertebræ have been diseased. In those cases where there are several foci of small extent, as sometimes occurs in the lumbar vertebræ, the whole of the body is not destroyed, but some parts remaining intact serve to support the trunk, and then there is no deformity. But in all other cases, as the body of the vertebra becomes destroyed, the vertebræ above sink down, and as they do so, the spinous processes project posteriorly and produce an obvious deformity, which may be recognised at a glance. When only one or two vertebræ are affected, this produces a true angular deformity; but when several bodies are involved, as frequently occurs in the dorsal region, it partakes more of the character of a curve. When the angular deformity has taken place, the head and the upper part of the trunk is not directed forwards, but a compensatory curve takes place in the vertebræ below the disease, which enables the upper part of the body to be carried erect. When the disease occurs in the lumbar region, this compensation cannot take place to any great extent, and therefore in these cases the patient stands or walks with the trunk inclined forwards. Secondary changes take place in the thorax, in those cases of dorsal curvature where several bodies are involved ; the sternum becomes bowed out and convex anteriorly, and the ribs attached to it become approximated to each other, so as to materially diminish the depth of the intercostal spaces. The lower two ribs, not being attached to the sternum, are not influenced by the curve, but remain in their normal position ; this produces a very well-marked sulcus around the trunk, between the tenth and eleventh ribs.

It must be borne in mind that the deformity is not produced entirely by the weight of the head and trunk causing the vertebræ above the disease to fall on those below ; for the deformity is found frequently to occur in cases of spinal caries when the patient is kept continually in the recumbent position. It must therefore be due in these cases to the action of muscles, which by their continuous contraction bend the body forwards.

Before leaving the subject of deformity, it is necessary to mention that in some rare instances, instead of its coming on gradually, it may be sudden in its onset, and this occurs usually from some injury in a case where the disease is already established, but where no change in the position of the bodies has as yet taken place. In these cases injury to the cord is likely to occur and paraplegia to result.

Abscess.—The formation of abscess is a most serious complication of caries of the spine, and unfortunately makes its appearance in many cases before the disease has been recognised ; the patient first consulting the surgeon for a swelling which has appeared in one of the situations where these abscesses point, the previous weakness of the spine, and the pain, if there has been any, having been disregarded. These abscesses have often therefore attained a very considerable size and travelled far from the position where they were first formed before they come under the care of the surgeon. The pus collects first on the front of the diseased vertebræ, beneath the anterior common ligament, and then travels outwards under the lateral border of the ligament, or else perforates this structure, and the course which it subsequently takes is determined by the arrangement of the fasciæ of the part and gravitation, and varies according to the part of the spine affected. Thus when the upper cervical vertebræ are affected it comes forward behind the pharynx, constituting retro-pharyngeal abscess (see page 717). When lower down in the cervical region, it travels outwards beneath the præ-vertebral fascia, and points behind the sterno-mastoid muscle, or occasionally perforates the fascia and points in front of the muscle. In rare instances it gravitates into the posterior mediastinum or into the axilla. When the disease is situated in the upper dorsal region, and sometimes in the mid-dorsal, it follows the course of the posterior branches of the intercostal vessels and nerves between the ribs, and points in the back on one or both sides of the dorsal spines. In other cases where the disease is situated in the mid-dorsal region, and generally when it implicates the lower dorsal vertebræ, it tracks down the posterior mediastinum, passes beneath the ligamentum arcuatum internum, and enters the sheath of the psoas muscle. Abscess arising from disease of the lumbar vertebræ may either track backwards along the posterior branches of the lumbar vessels and nerves and point in the loin, constituting lumbar abscess, or it may find its way into the sheath of the psoas muscle. The most frequent place, therefore, to find an abscess in connection with tuberculous caries of the spine is in the sheath of the psoas, not only because the pus derived from disease of a considerable portion of the spine has a tendency to find its way into this sheath, but also because this portion of the spine is the part which is most frequently diseased. These abscesses are called *psoas abscess.* They track down the sheath, sometimes lying in front of the muscular fibres, and at other times extensively destroying them, so that the nerves which pierce the psoas muscle may be seen crossing an abscess cavity, into which the sheath has been converted, entirely unsurrounded by muscular fibre. When the abscess reaches the brim of the pelvis, it spreads out under the fascia which covers the iliacus muscle, and which is continuous with the psoas fascia, and fills the iliac fossa. It then finds its way out of the iliac fossa, beneath Poupart's ligament, just external to the common femoral artery. Here the sac of the abscess is much constricted and forms a narrow neck. It now passes behind the femoral vessels, and usually comes to the surface at about the situation of the saphenous opening. In some instances, however, it may burrow down the thigh between the planes of muscles and point on the inner side, or pass backwards with the branches of the internal circumflex artery and point behind the great trochanter; or it may extend down into the leg, and, as in the classical case related by Erichsen, point by the side of the tendo Achillis. Occasionally an abscess in the iliac fossa may burrow into the true pelvis and find an exit through the sacro-sciatic foramen, or, as in a case under my care, may burst into the bladder.

Implication of the cord or the spinal nerves.—As before stated, the cord is rarely implicated as the direct result of the displacement of the vertebræ, but, nevertheless, in a certain percentage of cases, symptoms of pressure do arise. This is due, in the majority of cases, to an extension backwards of the inflammatory process through the posterior common ligament to the loose connective tissue which separates the dura mater from the bony walls of the canal; here an inflammatory exudation and formation of tuberculous granulation tissue take place, either in the form of a button-shaped mass of this material, which forms between the posterior surface of the bodies of the vertebræ and the front of the cord covered by its dura mater, or by a more diffused infiltration of the loose connective tissue with tuberculous granulation material, which may encircle the cord outside the dura mater for the extent of an inch or an inch and a half, and by its pressure causes anæmia and degenerative changes in the cord. The inner surface of the dura mater is not apparently affected, but the disease is confined entirely to the structures outside this membrane. In a small proportion of cases, paraplegic symptoms may be set up by the bursting of an abscess into the spinal canal, or by the presence of a sequestrum, which by displacement causes pressure on the cord. When the cord is affected in this way, paralysis is a more pronounced and earlier symptom than any interference with sensation. It is usually bilateral, and commences first as a weakness and loss of power in the muscles, so that the patient is unable to stand, though he can move his legs while lying in bed. This may be followed by starting of the limbs and rigidity when passive movements of the muscles are attempted. At this time the reflexes are usually exaggerated. Finally, painful spasmodic contractions of the limbs supervene, so that the patient lies habitually with his legs flexed on the thighs, and the thighs on the pelvis. Though the muscles waste, they still act to the faradic current. The reflexes now become diminished or altogether disappear. Sensation, which at first is little interfered with, later on becomes impaired. If the pressure is in the lumbar region the detrusor urinæ may be paralysed, but generally the patient empties his bladder periodically, but quite unconsciously.

A different train of symptoms is set up where the spinal nerves are pressed upon or irritated as they leave the cord and pass out through the intervertebral foramina; here we have neuralgic pains in certain special nerves, followed later on by loss of sensation and weakness, or loss of motion in the muscles supplied by the special nerves pressed upon. In these cases, supposing the pressure is sufficient to cause paralysis, the muscles would no longer react to the faradic current.

Diagnosis.—Little more need be said about the diagnosis of spinal caries than has been already said. In the early stages it is perhaps most frequently mistaken for hysteria; but the inconstant and more diffused character of hysterical pain, the absence of any true rigidity though the patient may hold his back stiff, and the presence of other signs of hysteria or of uterine derangement are usually sufficient to establish the diagnosis. Spinal caries may be mistaken for rheumatism, lumbago, or neuralgia, and it is not easy always to distinguish between them. The main points to be relied on are the presence of persistent fixed pain in the back, the absence of pain in any of the other joints, or history of a former attack of rheumatism. These, together with the occurrence of the disease for the most part in early life, and in a tuberculous subject, would lead one to suspect the existence of caries. The deformity of spinal caries may be mistaken for the kyphotic curvature of rickets; but it will generally be found that in this latter condition the curve disappears more or less completely upon holding the child up by its arms, or by laying the child flat on its stomach and then raising it gently by the ankles, so that the back becomes concave. The prominence in angular curvature does not disappear, while in rickety spine it does. In addition to this, there is not the same rigidity about the spine. From tumours of the spine, especially cancer, it cannot always be diagnosed at first; but the rapid increase of the symptoms in malignant disease, accompanied by emaciation, speedily settles the point. In erosion of the bodies of the vertebræ from aneurism there is the same fixed pain in the back, but a careful examination of the chest and abdomen will usually serve to exclude this disease.

The diagnosis of abscesses connected with spinal caries is not always easy, especially in cases of lumbar and psoas abscess. A lumbar abscess usually presents at Petit's triangle, just above the crest of the ilium, and the point which has to be determined is whether it is caused by disease of the bones of the spine or the pelvis. In the absence of any definite symptoms of spinal caries, it may be impossible to determine this point until the abscess is opened, when, if the disease is situated in the bones of the pelvis, it will probably be possible to feel the diseased tissue with the finger or a probe; whereas if the disease is in the lumbar spine the abscess will track upwards, and it may not be possible to feel the carious bone. In psoas abscess the diagnosis is often much more complicated. The principal diseases with which psoas abscess is likely to be confounded are

(1) an abscess in the groin arising from other causes; (2) femoral hernia; (3) cystic tumours; (4) soft solid tumours; and (5) aneurism.

(1) *Abscesses* in the groin, arising from many causes, may simulate psoas abscess, such as peri-nephritic abscess; a chronic abscess connected with disease of the appendix; an empyema perforating the diaphragm and tracking down to the groin; abscess connected with disease of the iliac bone, or hip joint; but the diagnosis may generally be made by a careful examination and a consideration of the previous history of the case.

(2) *Femoral hernia* often closely simulates psoas abscess. In both there is a soft tumour in the groin, which is reducible or partly so, and has an impulse on coughing; but in psoas abscess there is a fullness in the iliac fossa, which is generally quite sufficient to distinguish it from femoral hernia, even if the pain in the spine and deformity are absent.

(3) *Cystic tumours*—hydatids, serous cysts, and bursal tumours in the groin may be mistaken for psoas abscess, but here again the absence of any fullness in the iliac fossa ought to be a sufficient mark of distinction.

(4) The same may be said of *soft solid tumours*, such as fatty tumours and some forms of malignant tumour, in which also other diagnostic signs are present.

(5) Perhaps the disease which is most likely to be confounded with psoas abscess is a diffused *aneurism* of the lower part of the abdominal aorta or iliac artery. This aneurism, by its growth against the bodies of the vertebræ, gives rise to a fixed pain in the spine, and passing down to the groin, fills the iliac fossa and presents under Poupart's ligament; moreover, in many cases it does not pulsate. So that the similarity to psoas abscess is very great. The diagnosis is to be made, by the rapid growth, the absence of fluctuation, the alteration in the pulse below, and any symptoms which may arise from the pressure of the aneurism, as radiating pains in the course of the branches of the anterior crural nerve, and œdema and congestion of the leg.

Prognosis.—The prognosis with regard to spinal caries must vary with the length of time the disease has existed, the absence of complications, and the position of life of the patient. If the disease is seen and recognised early, before deformity has occurred, and especially in the children of the well-to-do classes, when treatment can be efficiently carried out, a very confident opinion of ultimate recovery may be given. But if the disease is allowed to run its course; or if, as is so often the case with the children of the poorer classes, the treatment is not persevered with for a sufficiently long time, then the prognosis is decidedly bad. After deformity has taken place, if there is no indication of the tuberculous material having caseated, the prognosis is still good (if treatment is efficiently carried out) as regards life, though it is probable that the deformity must always remain. Even after abscess has formed the case need not be despaired of, if it is judiciously treated. The abscesses may be cured, or they may dry up, the fluids being absorbed and the solid part forming a quiescent mass of putty-like material, under prolonged treatment, and the diseased spine ankylose and the patient recover. If, however, treatment is not strictly carried out the abscess will increase in size, will point and burst or be opened, and then, in the vast majority of cases, will, sooner or later, become septic, and the child's life be placed in great peril from hectic fever and subsequent lardaceous disease. Though even in some of these extreme cases the patient's life may be saved, the abscesses may heal up, leaving the patient a deformed and hopeless cripple. In those cases where paraplegia is present, there is also a prospect of recovery; either by long-continued rest the paralysis may disappear, or in some cases the operation of laminectomy may relieve it. Caries of the spine is more fatal in adults than in children. In adults, and especially patients above twenty-five or thirty years of age, if abscess supervene the case is almost always fatal. It must be borne in mind that as the disease is tuberculous there is always the risk of tuberculous disease being set up elsewhere, or of acute miliary tuberculosis supervening. As a rare complication, acute spinal meningitis may be set up in those cases where the dura mater has become involved by an abscess opening into the spinal canal.

Treatment.—The treatment of spinal caries, in the earlier stages, consists essentially in rest; and exactly the same method of treatment must be adopted as in tuberculous ostitis elsewhere. In order to bring about recovery the rest must be absolute and complete; and the best means of doing this is to keep the patient recumbent in bed for a considerable period of time. Some difference of opinion exists among surgeons as to whether the patient should be placed in the supine or prone position. No doubt there is much to be said in favour of the prone position, the greatest argument in its favour being that hypostatic congestion of the diseased parts is not so likely to occur; but it is exceedingly irksome, especially to the adult, and as a matter of practical experience I have found that the supine position answers remarkably well unless there is extensive deformity, when the weight of the body causes undue pressure on the prominent vertebræ, and under these circumstances the prone position should be adopted. One argument which is brought forward in favour of the prone position is that local applications in the shape of counter irritants can be more easily applied; my answer to this is that these applications are rarely, if ever, required. The patient should be placed on his back on a firm bed—a horsehair mattress with a fracture bottom is the best form of bed—and he should remain there, never being raised from the recumbent position. The body garments should be made so that they open behind, and can therefore be changed without moving the position; the under sheet must be changed without raising the patient, and the excreta must be passed in a bedpan. The patient must lie flat on the bed, with a pillow under the head only; unless the disease is in the cervical spine, and then all pillows must be dispensed with. In children there is sometimes a difficulty at first in preventing them occasionally raising themselves, as they are apt to forget. This may be prevented by a thin steel lath passed under the shoulder and tied at

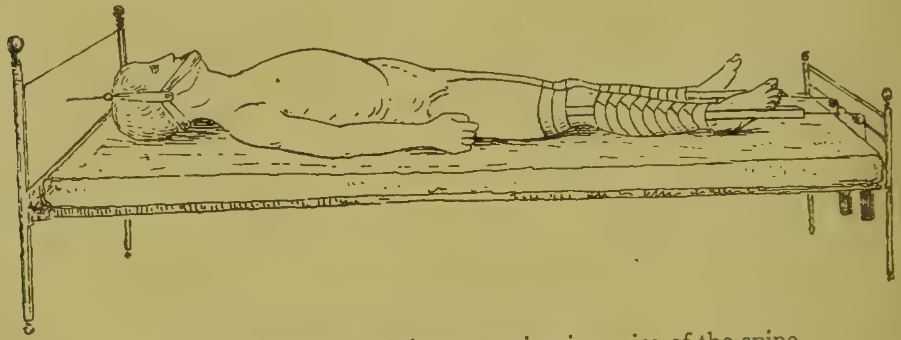

FIG. 295.—Mode of applying extension in caries of the spine.

either end to the sides of the bed. A loose webbing is passed under the lath on either side, and through this the arm is inserted, so that it lies loosely over the fronts of the shoulders. This prevents the child raising itself, but it is no restraint to the movement of the arms. Another question which will present itself to the consideration of the surgeon is whether extension is necessary. In the great majority of cases I believe it is not, except in disease of the cervical spine ; but in those cases where the fixed pain in the back is not relieved by confinement to bed, in a week or ten days, it is necessary. It can be applied by fixing the head to the top of the bed by two straps, one passed under the chin and the other below the occiput, and then making extension by weights attached to the legs and passing over pulleys fixed to the foot of the bed (fig. 295) The amount of weight required is about one pound for every year of age of the patient, up to five or six pounds ; more than this is rarely required for a child.

A most excellent contrivance for carrying out this treatment is Phelp's box. It consists of a wooden tray with sides about six inches deep. At the lower end it is divided into two compartments, one for either lower extremity, and in it is a suitable apparatus for the passage of the excreta into a receptacle fixed beneath. This is carefully padded, and the child placed in it and fixed by suitable webbings, and then padding is placed between the child and the sides of the box so as to fill up all the interstices. In this way the patient's trunk is completely immobilised. The box can stand on trestles, can be carried from room to room, or into the open air, or placed in a carriage. Extension can be made, if necessary, by elastic cords attached above and below to the ends of the box. In quite young children the spine may be immobilised by a double Thomas's splint, into which the child is fixed, and in which he can be carried about in the arms of the nurse.

The important question to decide is how long this treatment is to be carried on ; and the answer to this is that, in all probability, in a well-pronounced case the treatment should be persevered in for twelve months. This in the better class of patients can generally be managed, but in poorer people it is not so easy. Among the children of the poor it is often impossible to keep a child lying in bed at home for this long period of time, because there is no one to look after it, and it cannot be kept in hospital, where the beds are required for more urgent cases. In these patients, as soon as the pain has subsided and, in the opinion of the surgeon, there is no fear of matter forming, a rigid jacket of some light material should be moulded to the trunk, so that it reaches from the axillæ to the level of the trochanter, if the disease is in the lower dorsal or lumbar region, and be fixed on, being provided with shoulder straps. If the disease is in the upper dorsal or cervical region, the jacket must, in addition, be provided with a jury mast (fig. 296). The best material to make these jackets of is poroplastic felt ; but plaster of Paris is more economical, and though heavier,

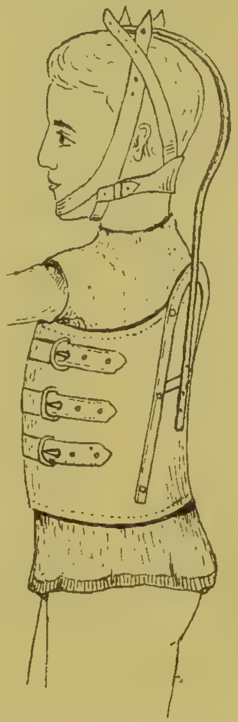

FIG. 296.—Jury mast in cases of disease of the cervical vertebræ.

answers sufficiently well. Some surgeons recommend that the jacket should be applied while the spine is in a state of extension; that is to say, while the patient, if an adult, is suspended by the head and axillæ on a suitably arranged tripod; or if a child, held up by the armpits. In my opinion this is not wise. By the time the case is ready for the jacket, a certain amount of consolidation is expected to have taken place, and the effect of the extension will be to stretch this new cicatricial tissue and produce in it a condition of irritation. In this jacket the patient may be allowed to get about. It is the practice of some to treat all patients in this way, and as soon as urgent symptoms have subsided, to get all of their patients up in a fixed apparatus and allow them to move about, under the plea that it is better for their general health. I do not think so. However well moulded a jacket may be, it does not so completely immobilise the spine as rest in bed, and after it has been in use for a short time it becomes bent out of shape, and then some movement at the seat of disease must take place. It is quite erroneous to think that the patient's health, especially if a child, suffers from the confinement to bed, if its hygienic surroundings are good. Every-day experience proves that children suffering from Pott's disease, if they are kept in bed, improve in their general condition: they regain their colour, eat heartily and sleep well, and usually increase in weight and stature.

During the treatment the general health of the patient must be attended to. The diet must be carefully regulated. Cod-liver oil and tonics may be considered necessary, and the bowels must be kept open. Constipation is often a considerable trouble in these cases. In children, it will often be found that a glycerine enema is the best remedy for this.

The treatment of chronic abscesses in these cases has already been described (page 118). In retro-pharyngeal abscess the opening is generally best made behind the sterno-mastoid (see page 717). In psoas abscess the opening should always be made above Poupart's ligament, as the constricted part of the sac at this ligament prevents the proper dealing with the cavity and the thorough evacuation of all the pus. A second opening may be made below the ligament, if judged necessary. Mr. Treves has recommended that psoas abscesses should be opened in the loin, at the outer border of the erector spinæ. An opening in this situation possesses the advantage that when the disease is in the lumbar region the bodies of the vertebræ can be explored and if necessary scraped, or any necrotic fragments removed. In the old days, when these abscesses were more frequently drained than they are now, the opening was also in the most dependent position.

Recently Mr. Victor Horsley has advocated a more radical treatment of spinal caries which has gone on to the formation of abscess. He considers that the universally accepted treatment of tuberculous ostitis in other parts of the body should be applied to this condition; that the diseased bone should be exposed and removed, and the cavity disinfected, so as to ensure, as far as possible, the destruction of any tubercle bacilli that may have escaped removal. In the cervical region he exposes the bodies of the vertebræ by an incision as for ligature of the internal carotid, and by drawing backwards this artery exposes the sac. In the dorsal region he performs a laminectomy, and then, when by examination of the tissues in front or at the side of the spinal cord the abscess has been discovered, he removes the nearest pedicle, and thus secures a thorough exposure of the cavity. In the lumbar region he reaches the abscess by

Treves's method. While the scraping out of the tuberculous material is proceeding, he irrigates the wound with 1 in 5,000 sublimate solution, and finally washes it out with 1 in 1,000.

When paraplegia supervenes in cases of spinal caries, it is not necessary in the majority of cases to alter the treatment, beyond relieving the bladder regularly if retention is present, and guarding against bedsores; but if the pressure symptoms actually threaten life, as in cases of intractable cystitis or of bedsores; or if the paraplegic symptoms persist for a long period, and are probably due therefore to the formation of scar tissue outside the dura mater; or where there is reason to believe that pus has found its way into the canal and is pressing on the cord, then the operation of laminectomy should be performed. It should also be performed in those rare cases where the disease is situated in the posterior part of the spinal column.

It should not be done when there is active tuberculous mischief in other organs, or when the symptoms of paraplegia have suddenly manifested themselves, or there is reason to believe that spinal meningitis is present.

Laminectomy.—The patient is placed on his left side, well rolled over to the right, and an incision is made in the middle line of the back over the prominent spines. The soft parts are reflected on either side, and with them the periosteum, until the bones are thoroughly exposed. The laminæ are then divided, close to the articular processes on either side, with a saw or strong cutting forceps, and the arch wrenched out with sequestrum forceps. Two, three, or more arches are removed in this way, until the vertebral canal is freely exposed. In some cases the dura mater will be found to be covered with a thick coating of tuberculous granulation, or fibro-cicatricial, tissue, and this is to be scraped away with a sharp spoon until the dura mater is exposed; care must be taken to prevent the blood running down the canal, and bleeding must be arrested by pressure. As soon as the posterior surface of the cord is cleared, it must be gently drawn first to one side and then the other with a broad, flat director, and the front of the canal cleared by scraping in a similar manner. The aim of the surgeon is to see returning pulsation in the cord, and he should not be satisfied until this is visible. The surface is now to be irrigated with sterilised water at a temperature of 105° F., or with some antiseptic solution, and the skin wound closed and dressed without drainage. Sensation, if it has been lost, usually returns first, and may be perfect in a few days. Motor power returns much more gradually.

Quite recently an old method of treating curvature of the spine by forcible reduction been has reintroduced. Dr. Calot, of Berck-sur-Mer, has been one of its chief advocates, though it has been extensively tried by some British surgeons. The operation is performed by making steady and uniform traction from the head and extremities of the patient, aided by direct pressure, if need be, on the prominent spines. There is no doubt that in many cases, especially in children, a very considerable curvature may be reduced, unless firm ankylosis has taken place, without injury to the spinal marrow; and moreover, that in some of those cases where paraplegia has existed before the operation, it has disappeared after its performance. But, in spite of this, we have no actual knowledge at present that the cases have been really benefited. A gap of considerable size, varying with the amount of curvature, must be left after the deformity has been remedied, which must be filled up before recovery can be said to have taken place. This necessarily takes place very slowly, and during this time fixation must be maintained. It remains to be seen whether the deformity will return, or whether, as seems more probable, it will recur. It would be premature, at the present time, to give a decided opinion as to the value of this proceeding.

Osteo-arthritis of the spine (*Spondylitis deformans*).—This disease occurs most frequently after middle life, and is more common in the male than the female.

Pathology.—The disease consists in an absorption of the intervertebral discs and the formation of bony outgrowths from the vertebral bodies, which by their interlocking, together with ossification of the anterior and posterior common ligaments, causes complete ankylosis of the spine (fig. 297). The joints between the articular processes become involved later on in the disease, and undergo the same changes as are found in osteo-arthritis of other joints. The **symptoms** are pain, which is worse at night and in damp weather; marked kyphosis and stooping; impaired mobility, especially in a lateral direction; and occasionally a grating on movement. The respiration may be affected, and where the disease is far advanced may be entirely diaphragmatic, and pulmonary troubles may ensue.

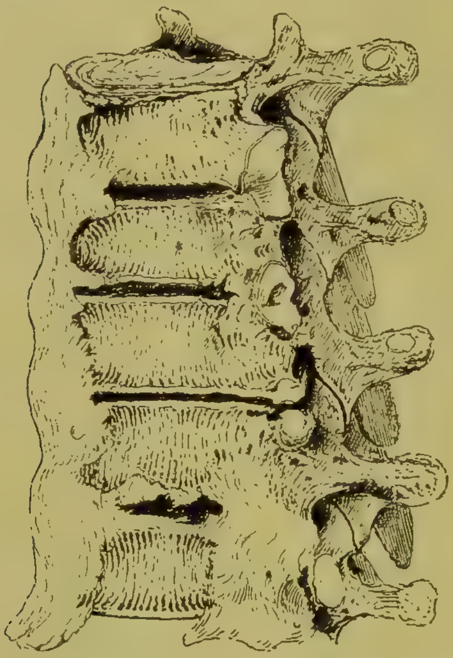

FIG. 297.—Osteo-arthritis of the spine. (From the Museum of St. George's Hospital.)

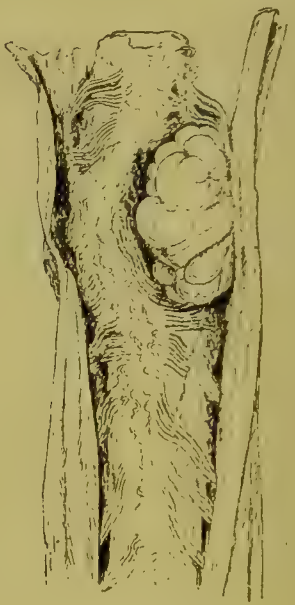

FIG. 298.—Sarcomatous tumour of the cord. (From the Museum of St. George's Hospital.)

The **treatment** must be conducted on the ordinary principles which guide the surgeon in the treatment of the same disease elsewhere. Residence in a dry climate is strongly indicated.

Syphilitic disease of the spine.—Gummata are occasionally met with beneath the periosteum, covering the bodies of the vertebræ and leading to caries and necrosis of the bone. When they occur on the posterior surface of the bodies they may lead to pressure on the cord and paralysis. Ordinarily they occur in front and give rise to symptoms resembling tuberculous caries, from which they can only be diagnosed by the history and coexistence of other syphilitic lesions.

The **treatment** is the same as that for tertiary syphilis elsewhere, conjoined with rest in bed.

Tumours of the spine.—Tumours of the spine are generally malignant, and may be either sarcoma or carcinoma—the sarcoma occurring as a primary growth; carcinoma as secondary to cancer in other parts, and especially the breast. The symptoms are severe pain, which is constant and is unrelieved by rest; muscular spasm, from irritation of the nerves emerging from the affected part of the spine, and pain in their peripheral terminations; paralysis, coming on at an early date; emaciation and weakness. The disease usually occurs after middle life, but sarcoma is sometimes met with in young children. The presence of severe localised pain and rapid emaciation in a patient past middle life should cause a suspicion of the nature of the malady, and the presence of cancer elsewhere would confirm it. All that can be done is to relieve the patient's symptoms by morphia, in the majority of cases. In those instances where the tumour grows from the posterior part of the vertebra, it may be successfully removed.

Tumours of the spinal cord may develop (1) between the dura mater and the bone: lipoma, hydatids, and sarcoma; (2) between the dura mater and the cord: gumma, sarcoma, myxoma, and fibroma; (3) in the substance of the cord: glioma, gumma, tubercle, and sarcoma (fig. 298). They give rise to pain of two kinds: fixed pain in the part, and pain extending along the nerves derived from the part of the spine which is implicated; often attended by cramp and spasm in the muscles supplied by the same nerve. This condition may be unilateral at first, but soon becomes bilateral. Paralysis of the parts below the seat of disease, with loss of sensation, is present. These cases, with the exception of the gummata, always terminate fatally. If, therefore, the administration of iodide of potassium produces no amelioration of the symptoms, it is justifiable to perform an exploratory laminectomy, in the hope that the tumour can be removed. Such tumours have been removed with success, and the patients recovered in whole or partially from their paralysis.

CHAPTER XII

INJURIES AND DISEASES OF THE CHEST

Contusions of the chest wall are usually the result of direct violence. In the simplest cases there is merely superficial bruising, and they differ in no respect from contusions in other parts of the body. More severe cases may be attended with rupture of one of the thoracic vessels beneath the pectoralis major muscle, and in these cases the effusion is often very extensive; so much so, as often to excite suspicion that the axillary artery or vein has been ruptured. Later on, the effusion may be mistaken for sub-pectoral abscess, which is apt to occur after injury of the pectoral muscle or the connective tissue beneath; but the diagnosis may be made by the history of its sudden and rapid appearance, and by the absence of any inflammatory signs. Cases have been recorded where contusions of the chest have proved fatal, either instantaneously or after a short interval, without any fracture of the ribs or gross lesion of the thoracic contents.

The **treatment** is that of bruises elsewhere—keeping the part perfectly at rest, and applying cold in the shape of ice or evaporating lotions.

Occasionally injuries of the wall of the chest may be attended with rupture of muscles, more particularly the great pectoral muscle. This is produced by some sudden strain, as falling from a height and catching at some projecting object with the hand; or it may be produced by a spent cannon shot, or during efforts to reduce a dislocation of the shoulder with the heel in the axilla. The injury may be recognised at once by the great gap which is found in the anterior wall of the axilla, and the loss of the functions of the muscle.

The **treatment** is the same as for ruptured muscle elsewhere: approximating the torn ends of the muscle as far as possible by position, and keeping the arm quiet.

Fracture of ribs.—The ribs are very elastic and much curved, and strengthened on their inner surface by a strong ridge; they are connected in front to a movable sternum by highly elastic costal cartilages, and behind to the vertebræ by strong ligaments. They are thus able to withstand great violence; but in consequence of being exposed to frequent injury they are more commonly broken than any bones in the body, with the exception of the clavicle, the bones of the forearm and the leg. Fracture of the ribs is most common in advanced life, after the costal cartilages are ossified and the ribs themselves have lost some of their elasticity. In infancy and childhood fracture of the ribs is uncommon, owing to their extreme elasticity, and severe injury may occur to the thoracic contents, from crushing violence, without the ribs being broken. In individuals the subjects of general paralysis of the insane, the ribs become atrophied and very fragile, and under these circumstances they break with the slightest violence.

The middle series of ribs, the fifth to the eighth, are the ones most commonly broken. The first, and to a certain extent the second, are protected by the clavicle, and are not often broken as an uncomplicated injury; though a sufficient number of cases of fracture of the first rib alone have been recorded of late years to prove that this injury does occasionally occur. The two floating ribs are not often broken, but fracture may take place in these ribs, and is often attended with considerable displacement. One rib only may be broken; more commonly the fracture is multiple, and two, three, or more ribs are fractured (fig. 299). In some cases of severe injury, as from a buffer accident, almost all the ribs on one side may be fractured, and in the worst cases the ribs on both sides may be broken.

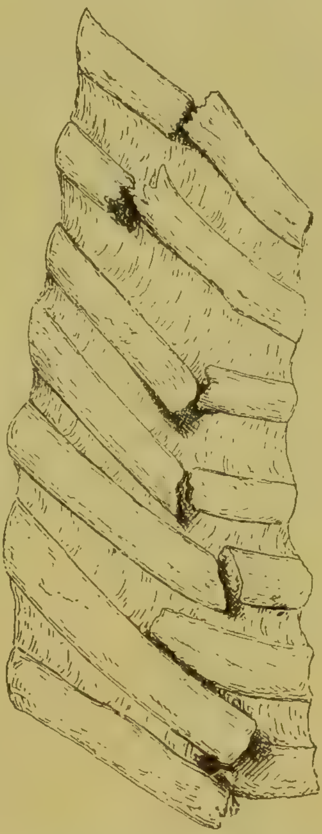
FIG. 299.—Fracture of several ribs, with displacement. (From the Museum of St. George's Hospital.)

Causes.—The ribs are most frequently broken by *indirect* violence, as in cases of violent blows on the front of the chest, or from a carriage wheel passing across it. The fracture usually takes place in the posterior third, some little distance in front of the angle: the rib first bends under the compressing force and then gives way at its weakest part, being broken outwards. Fracture of the ribs may also occur from *direct* violence, the bone breaking at the point struck. These fractures generally occur on the front of the chest, and the bone is broken inwards. There is usually more displacement in these fractures than in those caused by indirect violence. Finally, cases have been recorded where fracture of the ribs has been caused by *muscular action*, during violent expiratory efforts, such as coughing, sneezing, or during parturition. It would seem probable in most of these instances that the rib had been previously weakened by disease, either in cases of general paralysis of the insane, or where a rarefying ostitis has taken place, as sometimes occurs in young people.

Complications.—Fracture of the ribs may be compound, either externally through the skin, though this is not very common except in fractures from stabs or gunshot injuries, or internally through the pleura. In those cases where the fracture is compound internally through the pleura, the lung may be injured, either slightly wounded or severely lacerated. In other cases the pericardium and the heart may be injured. When the lower ribs are fractured, the diaphragm may be pierced, and some of the abdominal viscera, the liver, the spleen, the stomach, or the intestine may be injured. Finally, in some cases of fractured ribs, the intercostal vessels may be torn, and considerable extravasation of blood take place.

Symptoms.—There is a curious fact about fracture of the ribs—that the patient will often tell the surgeon that he was conscious of an audible snap at the time the bone was broken. No doubt in every fracture there is this audible snap at the moment the bone breaks, but patients as a rule are not conscious of it, except in fractured ribs, and perhaps sometimes in spontaneous fractures. The patient complains of a sharp fixed pain, which is increased by taking a deep inspiration, or on any violent expiratory effort, such as coughing or sneezing. If he is stripped and examined it will be noticed that the movement of the chest wall during respiration is not so great on the injured side as on the sound side. Where a single bone is broken from indirect violence, there is rarely any obvious displacement; but where several ribs are fractured, or sometimes in fractures from direct violence, the deformity is very marked. In these latter cases, on the front of the chest there may be a distinct depression corresponding to the seat of the injury. Where a rib is broken in two places, as sometimes happens, the loose portion may be felt to move independently of the rest of the bone. On pressing the rib which has been injured, at some little distance from the site of the fracture, so as to move the broken ends on each other, crepitus may be elicited, and the proceeding is attended with an increase of the pain. Crepitus may also sometimes be felt by placing the hand flat over the injured spot and causing the patient to take a deep inspiration; or it may be heard by placing a stethoscope over the site of the fracture, when the broken ends may be heard grating against each other during the movement of the thorax in respiration.

Mode of repair.—The mode of union of a fractured rib affords one of the best examples of union by provisional callus. Owing to the impossibility that there is of keeping the ends of the bone in a condition of absolute immobility, a large amount of provisional callus is thrown out, which rapidly ossifies and completely solders the fractured ends together in three or four weeks. The process of union by definitive callus goes on more slowly, and when it is completed the provisional callus is absorbed, and the site of the fracture in process of time becomes scarcely distinguishable. Non-union of a fractured rib is very uncommon, but has been recorded.

Treatment.—The best mode of treating a fractured rib is by strapping. This is far superior to the old-fashioned plan of swathing the chest in a rib roller, which compresses the sound side of the chest as well as the injured side, and interferes with respiration. The affected side is firmly strapped with strips of adhesive plaister, about a couple of inches wide, which should be laid on from below, in such a manner that each strip covers about half the width of the one below, and so that each strip projects beyond the middle line both in front and behind. As each piece is applied the patient should be instructed to empty his chest as much as possible; for if the plaister is applied during inspiration the strapping becomes loose as soon as the patient empties his chest. This application usually gives great ease and comfort to the patient and relieves his pain, but in some cases, where the broken fragments are driven inwards, it causes them to press upon the pleura or lung, and increases the pain; or, if in the lower part of the chest, to irritate the diaphragm and produce hiccough, and under these circumstances cannot be borne. In patients with advanced pulmonary emphysema, or chronic bronchitis, fixation of the chest adds to the difficulty in respiration, and sometimes causes fatal engorgement. Strapping should not therefore be employed in these cases, but the patient placed in bed in a bed chair, or propped up with pillows, and the fracture allowed to take care of itself.

Fracture of the costal cartilages is not a common injury, and when it occurs is usually produced by direct violence. The cartilage of the eighth rib is the one most frequently broken, and the fracture is almost always vertical. If there is no displacement, it may not be recognised. Where there is displacement, the internal or sternal fragment rides upon, or is in front of, the external or vertebral fragment if the fracture is near the sternum, but may be in either direction when the injury is situated near the vertebral extremity. The **symptoms** are persistent pain over the seat of injury, with a certain amount of swelling and bruising, and possibly an obscure sensation of crepitus. If displacement is present, the line of irregularity in the cartilage can be felt. The union is usually by bone. The **treatment** is the same as for broken ribs.

Fracture of the sternum.—The sternum is not often broken, except from indirect violence in conjunction with fracture of the spine. As an independent injury it may be broken by direct violence, in gunshot wounds or stabs, but is rarely broken by blows or crushes, on account of the elasticity of the ribs and shoulder girdle, on which it is supported. By indirect violence it may be broken by over-flexion of the spine, as in a fall on the head, with impaction of the chin against the bone; or by over-extension of the spine, and is then generally complicated and obscured by a fracture of the spine itself. Cases have been recorded in which it has been said to occur from muscular action. The fracture is usually transverse or slightly oblique in direction, and takes place somewhere between the middle and upper border of the gladiolus (fig. 300). Sometimes a displacement occurs between the manubrium and gladiolus, and is classified as a fracture of the bone. The manubrium is not often broken. In transverse fracture there is sometimes no displacement. If displacement does occur the lower fragment is usually displaced forwards, but may be carried backwards, behind the upper fragment.

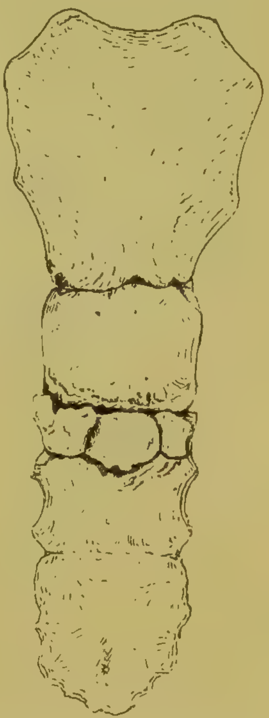

FIG. 300.—Fracture of the sternum. (From the Museum of St. George's Hospital.)

Symptoms.—There is fixed pain in the part, which is increased on movement or making a forced inspiratory effort. Crepitus can sometimes be felt by placing the hand over the injured part and making the patient take a deep inspiration. There is usually some bruising, and if displacement is present an abrupt prominence can be felt, with a depression above if the lower fragment is displaced forwards. In some cases the patient assumes a characteristic attitude: the head and trunk are bent forwards and carried in a rigid and fixed manner.

Treatment.—Any displacement which may exist can usually be corrected by placing the patient on his back, with a firm cushion under the chest so as to forcibly bend the body backwards; the bone will then generally recede into position, or can be pushed there. Strapping or a rib roller should then be applied.

Wounds of the chest wall.—These wounds are of various kinds, but are most commonly of the punctured variety, and are due to stabs with some sharp-pointed instrument, as a knife, sword, or bayonet. They may be non-penetrating or penetrating. The former are not of much importance, and must be treated as similar wounds in other parts of the body.

Penetrating wounds of the chest wall, when uncomplicated, are wounds in which the pleura costalis has been perforated without wound of the pleura pulmonalis or lung. They are of very rare occurrence, since a wound which has divided the parietal layer of the pleura, in most instances, injures the lung also; but they do occur, and are believed to be due to the fact that the injury was caused by a blunt weapon, which pushes the lung before it. They may also occur in those cases where the pleural sac is opened below the level of the lung. That penetration has taken place is usually evident by the fact that air can be heard bubbling into and out of the chest (traumatopnea); or blood may be expelled with each forcible expiration or during coughing; or the lung may protrude through the wound. But these signs may be absent, and then the condition of things can be ascertained by the careful introduction of an aseptic finger, which is less likely to do harm than a probe.

The **signs** that penetration of the chest wall has taken place without wound of the lung, are moderate emphysema about the wound, produced by air being sucked into the wound during inspiration; and failing to escape during expiration, through the lips of the wound falling together, it is driven into the subcutaneous tissues; traumatopnea, or escape of air from the wound, sometimes with a whistling noise; and pneumothorax, from air being sucked through the wound into the pleura and being unable to escape. There is no hæmoptysis or hæmothorax, as commonly occurs when the lung is injured. The injury is followed by subsequent pleurisy. This may be simply local, set up by the injury, but as the entrance of septic organisms with the air passing into the wound is possible, it is very often infective in its character.

Treatment.—It is scarcely necessary to discuss the treatment independently of punctured wounds where the lung is injured, as it is the same. It mainly resolves itself into strict attention to asepsis.

Complications.—A penetrating wound of the chest may be complicated with (1) wound of one of the intercostal or internal mammary vessels; (2) injury to the diaphragm; or (3) hernia of the lung.

1. **Wound of the intercostal vessels** is not common in punctured wounds of the chest, as they are protected by the overhanging inferior border of the ribs. Wound of the internal mammary vessels is more likely to occur in cases of punctured wounds of the front of the chest. There is sometimes considerable difficulty in ascertaining in cases of hæmorrhage from a wound of the chest whether the blood comes from a wounded vessel in the parietes or from a wound of the lung; for if the opening is at all valvular the blood does not escape, when a parietal artery is wounded, with a jet, but is spirted out with each expiration and cough, as it would be in wounds of the lung. Moreover, it is mixed with air, which is sucked in from without. The diagnosis can usually be made by introducing the finger into the wound and making pressure against the rib in the course of the vessel. This will arrest the bleeding if a parietal vessel is injured, but will have no effect on hæmorrhage from the lung. Moreover, in those cases where the lung is uninjured there will be no hæmoptysis.

Treatment.—The best treatment is to expose the bleeding vessel and tie it. This is sometimes difficult, especially in the case of the internal mammary artery, and it may be necessary to remove a portion of the costal cartilage or tie the vessel in the space above. With regard to the intercostal vessels, the hæmorrhage often continues because the artery has been incompletely divided; complete division and seizing the bleeding point with a pair of clip forceps, which can be left on and packed with the dressing, will usually suffice, if the vessel cannot be tied. Tampon plugs are sometimes used, but cannot be recommended. A square piece of aseptic linen is laid over the wound and pushed partly into the pleural cavity with the point of the finger. The bag thus formed is packed with gauze and then tied round the mouth with a piece of silk. By now pulling on the portion of linen which remains outside, firm pressure is made on the parietes around the wound, and the hæmorrhage is stayed. It is very seldom that this plan of treatment is required.

2. The **diaphragm may be injured** in punctured wounds of the lower part of the chest, and some of the abdominal viscera, the stomach or colon especially, may protrude into the thoracic cavity and may become strangulated.

3. **Hernia of the lung** is a rare condition. It may be either (1) immediate or (2) subsequent.

(1) **Immediate hernia** of the lung (*prolapse*) occurs in extensive wounds of the parietes of the thorax, when a portion of the lung is protruded during expiration. It is easily recognised, and, if recent, it should be at once carefully cleansed and returned by pressure. If not soon reduced, adhesions form between the two layers of the pleura, and it is then irreducible and may ultimately become gangrenous and slough off, or it may shrivel up and almost disappear. It may be removed, where it cannot be reduced, by ligature and the knife, or by searing it off with the actual cautery. Guthrie recommends that it should be left alone and allowed to slough off.

(2) **Subsequent hernia** of the lung (*pneumocele*) generally occurs where there has been an external wound, the cicatrix of which yields. It may also be caused from weakening of the chest wall from fractured ribs, without an external wound, or from giving way or rupture of the intercostal muscles from violent expiratory efforts, as in labour or cornet-playing.

Symptoms.—Pneumocele forms a soft compressible tumour, which increases in size during expiration or coughing, and can be diminished or altogether disappears on pressure. It gives to the hand a soft crepitant feel, and with the stethoscope a fine crackling sound can be heard. It does not appear in any way to shorten life, and the only **treatment** which is necessary is to fit the part with a concave shield which will support the tumour and prevent its increase.

INJURY TO THE THORACIC CONTENTS

Contusion of the lung.—In these cases there is bruising of the lung tissue, with extravasation of blood into the air cells, without any lesion of the pleura. The extravasated blood gradually breaks down, and is discharged by coughing. It is a not uncommon complication of fracture of the ribs, but may occur independently of this lesion. In slight cases there may be no appreciable symptoms for some days, at the end of which time the patient coughs up a quantity of rusty sputum; but in severer cases there is paroxysmal difficulty in breathing, resembling asthma, and if a physical examination of the chest is made there will be found to be a circumscribed area of dullness, over which coarse crepitations or sometimes fine moist râles will be heard. After some days the patient coughs up a quantity of dark viscid sputum, and as this is got rid of the dyspnœa is relieved and he eventually recovers. These cases are to be treated by rest in bed, the patient being well propped up by pillows, or in a bed chair. The room should be kept at an equable temperature, and expectorants should be given.

Rupture of the lung.—This may occur without any fracture of the ribs. There is simply a laceration of the lung tissue, with tearing of the visceral pleura, without any lesion of the chest wall. It usually occurs in children or young persons, and in a large percentage of cases the laceration takes place near the root of the lung, so that the large vessels are torn and death results from hæmorrhage. When death does not take place speedily, the presence of pneumothorax and hæmothorax, without any penetrating wound of the thoracic wall, indicates the nature of the lesion.

Wound of the lung.—Wounds of the lung may be of two kinds: (1) from a fractured rib perforating the lung, without any external wound; and (2) from a wound from without, which has transfixed the chest wall. The distinction is of importance, since in the first class of cases the air which finds its way into the pleural cavity from the torn air cells and air passages has been filtered of its organisms by its passage through the lungs, and therefore no infective inflammation is likely to occur; whereas where there is an external wound the air passes unfiltered through it into the pleura, and septic organisms may be introduced into the pleural cavity and an infective inflammation may be set up.

1. **Wound of the lung from fractured rib, without external wound.**—In a case of fractured rib the lung may be known to be wounded if there is surgical emphysema around the fracture, and if there is constant tickling cough, with expectoration of frothy bloody mucus. The former of the two is the more constant sign.

If a lung is torn by a broken rib both air cells and blood-vessels are lacerated, and there must therefore be effusion of air and extravasation of blood.

(1) Air may be effused in these cases into (*a*) the subcutaneous tissue, constituting what is known as surgical emphysema; or (*b*) into the pleural cavity, constituting pneumothorax.

(*a*) **Surgical emphysema** may arise also in cases of punctured wounds of the lung; from wounds of the thoracic parietes, without wound of lung (see page 780); and from rupture of the air cells from disease or from violent straining, as in parturition. Emphysema from fractured ribs generally occurs without any air getting into the pleural cavity. When the pleura costalis and pulmonalis have been perforated by a broken rib, which then penetrates the lung substance, the air which escapes from the wounded air cells passes directly outwards through the wound in the two serous layers, which lie in close contact and are not separated from each other, because the pressure of the air is not sufficient to separate them, and finds its way into the subcutaneous tissue. In some cases, however, where the pressure is greater, the air escapes into the pleural sac during inspiration, and is then forced out into the cellular tissue outside the thorax, through the wound in the pleura costalis, during the succeeding expiration, and the emphysema is complicated with pneumothorax

Symptoms.—The symptoms of surgical emphysema are a puffy swelling, which starts from the neighbourhood of the injury and may gradually spread until it involves the whole of the injured side of the trunk, and may extend up the neck to the face, or on to the extremities. The swelling is pale and tallowy, and when pressed upon affords a peculiar crackling sensation, which when once experienced can hardly be mistaken for anything else. The same crackling is to be felt in some cases of gangrene from the evolution of the gases of decomposition into the cellular tissue, but the diagnosis is at once made by the discolouration of the skin in gangrene, and the constitutional symptoms. When the swelling is so great that it extends into the neck, there is danger from pressure on the trachea.

Treatment.—When the emphysema is not extensive no treatment is necessary; it will rapidly disappear. It is better in these cases not to apply a bandage, as this might prevent the air escaping into the cellular tissue, where it does no harm, and cause it to collect in the pleural cavity. If the emphysema is great, and especially when it causes pressure on important organs, as the trachea, minute punctures should be made in great number, so as to allow of the escape of the air externally. This proceeding is rarely necessary.

(*b*) **Pneumothorax.**—The causes are the same as those which produce surgical emphysema, but in addition to these it may sometimes occur in cases of phthisis, from the giving way of a vomica.

The **signs** of this condition are urgent and excessive dyspnœa, resonance of the chest on percussion, and amphoric respiration, which may be described as a sound resembling the noise heard by blowing obliquely into an empty flask. The heart is displaced to the opposite side.

Treatment.—If the symptoms are urgent, so as to threaten life, the chest should be tapped with a trocar and cannula and the air allowed to escape, which it will do generally with a hissing sound; and the lung, which has been compressed, will at once expand.

(2) In cases of wound of the lung from a broken rib, blood may be extravasated into (*a*) the subcutaneous tissue, (*b*) into the pleural cavity, or (*c*) into the substance of the lung. (*a*) When it is extravasated into the subcutaneous tissue it constitutes an ordinary bruise, which differs in no respect from contusions in other situations. (*b*) When it is poured out into the pleural cavity (*hæmothorax*) it may produce speedy collapse and death, if it is poured out in large quantities. When the extravasation is less, there are signs of fluid in the pleural cavity, coming on shortly after the injury, and attended by syncope, vertigo, paleness of the face and blanching of the lips, and short and hurried breathing. The physical signs of fluid in the chest are increased capacity on the affected side, with bulging of the intercostal spaces; dullness on percussion, which may be universal if the cavity is full, or at the most dependent part if it is only partially filled; and absence of the normal respiratory murmur, the breath sounds being tubular in character. There is loss of vocal fremitus and bronchophony. (*c*) In wounds of the lung, the blood may be extravasated into the lung substance around the injury, producing a condition resembling pulmonary apoplexy. In these cases there is a circumscribed area of dullness on percussion, which does not alter in position with changes in posture of the patient, and over which there is loss of the respiratory murmur. In addition to these situations into which the blood, in injury of the lung, may be extravasated, it may find its way into the bronchial tubes and may be expelled by coughing (*hæmoptysis*). Some-

times this may be so abundant as to cause death in a short time, but in the generality of cases it ceases in the course of twenty-four hours.

Inflammation of the lung and pleura follows wound of the lung; but when the wound is subcutaneous, as in those cases which we have just been considering, the inflammation is generally local and shows no tendency to spread beyond the injured parts. This is because, though air is admitted to the wound, it is filtered before it reaches the injured tissues, and therefore contains no septic germs to set up an infective inflammation. It has been abundantly proved by Tyndall and others that all foreign particles, which are introduced into the air passages with the air we breathe, are arrested in the larger bronchial tubes, and that therefore the air which enters the air cells is pure and contains no sources of contamination. Even in cases where the pleura is injured and blood accumulates in large quantities in the pleural cavity, suppuration rarely takes place, for the simple reason that there are no pyogenic micrococci to excite it. The blood is absorbed, or in some cases, acting as a framework, it causes adhesion of the two layers of the pleura to take place, by a process analogous to union of wounds by blood clot (see page 56). There is necessarily a localised traumatic inflammation about the injury in the lung, set up for the process of repair. The inflammatory exudation fills the air vesicles, and thus causes a consolidation of the lung by scar tissue at the injured spot.

2. **Wounds of the lung with external wound.**—These cases are very much more serious than those of subcutaneous wound from a fractured rib, as unfiltered air is admitted from without, and there is danger from septic inflammation. They may be produced by stabs from sharp cutting instruments; wounds from blunt bodies, as where a man has been struck on the chest from the shaft of a carriage in motion; or from gunshot wounds (fig. 301). These latter are probably the most severe, because they are often of great depth and may be complicated by the lodgment in the lung of particles of clothing, pieces of bone, or the bullet itself. A penetrating wound of the lung is recognised by the presence of an external wound, through which air is drawn in and out during respiration, often with a whistling or bubbling sound (traumatopnœa), with other signs of wound of the lung, hæmoptysis, emphysema, &c. The patient experiences a sense of oppression about the chest, with difficulty in breathing, and a constant tickling cough, and is usually much collapsed. The hæmorrhage is sometimes very great, when the wound has implicated the large vessels at the root; so profuse as to destroy life in a few minutes, either from loss of blood or from suffocation, from the blood finding its way into the larger

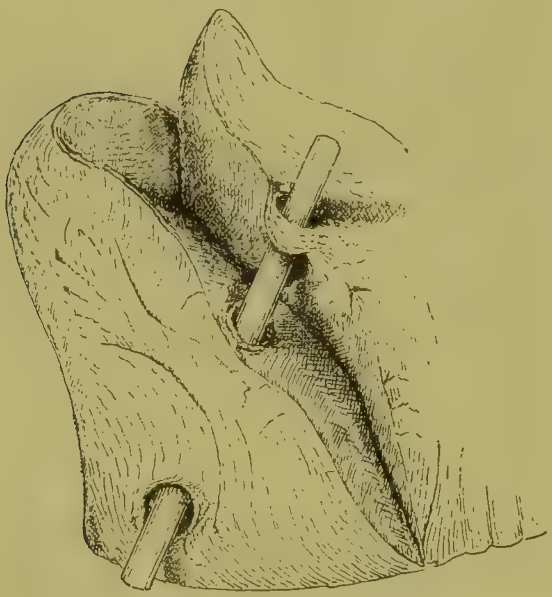

FIG. 301.—Gunshot wound of the lung. (From the Museum of St. George's Hospital.)

bronchial tubes. If the external wound is not large or valvular, the blood may collect in the pleural cavity and fatally compress the thoracic viscera. Fatal hæmorrhage is more likely to occur in wounds from sharp pointed instruments, and this is the great danger to fear in wounds of this description. When the wound is oblique, there is the risk of air as well as blood collecting in the pleural cavity; but these wounds are not so liable to be followed by septic inflammation as a wound from a blunt instrument, which can scarcely heal by first intention. In these latter cases decomposition of the extravasated blood and inflammatory effusion frequently occurs, and the presence of the irritating products of putrefaction in the wound may lead to an extension of the inflammation, with suppuration and possible gangrene of the lung, or may set up a condition of septicæmia from absorption of the ptomaines.

Treatment.—In wounds of the lung from a sharp instrument in which the bleeding has ceased, an attempt should be made to obtain union by the first intention. The parts around the wound should be carefully cleansed, the edges of the wound brought together with sutures, and dressed antiseptically. It is better to abstain from all examination of the wound with probe or finger, as the proceeding might dislodge clots and cause a return of the hæmorrhage. It is not desirable that the wound should be syringed out with an antiseptic solution, as this might find its way into the pleural cavity, and, if the wound is deep, into the bronchial tubes. In bullet wounds, or in lacerated wounds from blunt instruments, a careful exploration with an aseptic finger or a probe should be made, to detect if possible any particles of clothing, pieces of bone, or bullet, and if found, these should be removed. The examination must not, however, be carried too far, and must be conducted with the greatest gentleness, so as to avoid displacing any clots and causing a renewal of the hæmorrhage. The parts around must be thoroughly cleansed, and dressed with an antiseptic dressing without closing the wound. As a rule, it is not necessary to insert a drainage tube. The patient must be kept in bed, lying on the injured side in order to secure efficient drainage, and to keep the injured lung as far as possible at rest. When hæmorrhage is still going on, the first duty is to take measures to arrest it. If it comes from an intercostal vessel it must be treated as described on page 780; but when it comes from a pulmonary vessel, there are two or three different plans which may be adopted. In the majority of cases the bleeding may be stayed by the administration of hæmostatics and the application of cold, the patient being kept absolutely quiet on the injured side, with the wounded part of the chest in the most dependent position, covered by a thick absorbent pad into which the blood can drain, and which should be changed as often as is required. Opium should be administered in order to insure quietude, and with this may be combined ergot and sulphuric acid; or ergotine may be administered subcutaneously. Sometimes the hæmorrhage will not cease until the patient is in a state of extreme collapse and syncope. The observation of this fact induced surgeons, until quite recent times, to produce syncope by a rapid venesection, in the hope that the weakened action of the heart would propel the blood through the vessels so feebly that coagulation would take place in and about the divided ends, and so the hæmorrhage would be stayed. The plan has now been abandoned and is not to be recommended. It has been advised by some that in cases of severe hæmorrhage the external wound should be plugged so that the blood might accumulate in the pleural cavity, and by its mechanical pressure on the wounded lung cause the arrest of the hæmorrhage. This may succeed sometimes, but is not without its disadvantages and dangers; for the collection of blood in the pleura may threaten suffocation, under which circumstance the wound would have to be opened up and the blood allowed to escape. Or, later on, this mass of blood in the pleura, unless it is got rid of, will, in most cases, undergo putrefaction and cause a very serious condition of things. This plan of treating the hæmorrhage cannot therefore be recommended. Of recent years it has been proposed to lay the chest wall freely open, and deal with the wound in the lung in a much more thorough manner than has hitherto been attempted. We have, however, very little knowledge on the subject at present, but it seems probable that in the not far distant future this proceeding may become a recognised plan of treatment, and we shall deal with these cases just in the same way as we deal with a laceration of the liver or any other of the abdominal organs.

If the patient survive the first two or three days, there is always a danger of pneumonia or pleurisy, or, in most cases, both, being set up. The inflammation in these cases is very different from the localised traumatic inflammation which, as we have seen, occurs in subcutaneous injuries; here bacteria have found an entrance through the external wound, and septic inflammation is the result, with its attendant grave constitutional symptoms. When the lung is involved the physical signs of consolidation may be present—dullness on percussion, fine crepitations, bronchial breathing and bronchophony, and increased vocal fremitus; but these signs are usually masked by the concomitant inflammation of the pleura, which is attended with effusion, and this, mixed with extravasated blood, is a highly putrescible animal matter, to which organisms have been admitted from without, and it therefore rapidly undergoes putrefaction, and the cavity becomes filled with offensive, stinking pus (empyema). In these cases the constitutional symptoms are most severe, and the patient may die rapidly from absorption of the products of putrefaction. The presence of empyema may be recognised by the patient presenting the physical signs of fluid in the chest (see page 783), conjoined with the history that the signs have not come on for some time after the injury, and are accompanied by severe constitutional symptoms—i.e. high temperature, rigors, a quick pulse, hot skin, and furred tongue.

The **treatment** consists in providing for the freest possible drainage, by enlarging the original wound and making a counter opening, if necessary, and inserting a large drainage tube. If the discharge is offensive the cavity of the chest must be washed out. This, however, is a proceeding which is not unattended with risk, and several cases have been recorded where it has been followed by sudden death. Care must be taken, therefore, not to use any force so as to over-distend the chest. It should never be done with a syringe, but by gravitation, the vessel containing the fluid not being raised more than three or four feet above the patient. The fluid should be between 100° F. and 105° F., and should not contain any irritating antiseptic; probably hot sterilised water is the best.

Paracentesis and incision of the chest.—When fluid has collected in the pleural cavity, it may require removal, whether it is blood, serous effusion, or pus. Blood, as a rule, does not require removal, it is speedily absorbed; but in some cases it may accumulate in such quantities as to threaten suffocation; or in other cases, where there has been an external wound, and it has been plugged to arrest hæmorrhage from the lung, signs of suppuration may supervene. Under these circumstances the blood should be evacuated without delay, either by opening up the wound, if one exists, or making a free incision in the most dependent part, and subsequently employing antiseptic drainage. If the fluid is a serous effusion, it may be withdrawn by means of an aspirator, and this operation should be performed when medical treatment fails to cause absorption of the fluid, if the effusion is so considerable as to compress the opposite lung, or to produce orthopnœa; or in those cases where there are signs of failure of the heart's action. When the fluid is pus, it should in almost all cases be evacuated by a free incision through the chest wall. An exception to this rule may possibly be made in those cases of empyema following an attack of pneumonia, as they will sometimes recover after a simple aspiration, and the cavity will not refill. The existence of this form of empyema may be established by an examination of the pus withdrawn, which will be found to contain pneumococci, but no pyogenic cocci or tuberculous bacilli.

There is often some difficulty in ascertaining from the general symptoms whether the fluid in the pleural cavity is merely serum (hydrothorax) or pus (empyema), and therefore it is advisable to commence operations by investigating the case by means of the exploring syringe. In this way a small quantity of fluid can be withdrawn and if necessary subjected to microscopic examination. If pus is found, in the majority of cases the operation of incision of the chest wall and subsequent drainage should be proceeded with.

The operation is performed as follows: The site having been selected, the parts around are to be properly cleaned and rendered as aseptic as possible. Considerable difference of opinion exists as to the best position for the opening. Some believe that the fifth intercostal space in the mid-axillary line is the best. Others prefer a spot lower down and further back—namely, just below the inferior angle of the scapula or in the posterior axillary line, in the seventh, eighth, or ninth interspace, because it is at a more dependent part, and therefore is said to afford more efficient drainage. On the whole, the incision in the mid-axillary line in the fifth interspace is the best. It is the most dependent part when the patient is lying on his side: there is less thickness of muscular tissue to cut through; the ribs are here farther apart, and as the lung expands this is the last part of the chest wall with which it comes in contact, so that there is no danger of the external wound becoming closed before the fluid is entirely evacuated. The operation can be performed with or without the resection of a portion of the rib. Probably in the majority of cases it is wiser to remove about an inch of the rib; it gives freer drainage, and is certainly desirable in children.

The patient should be brought to the edge of the bed, so that the side to be operated on slightly overlaps the margin as he lies on his back. This position is to be preferred to rolling him over on to his sound side, for under these circumstances the accumulation of fluid may embarrass the breathing in the sound lung. An incision about two inches in length is made over the sixth rib in the mid-axillary line, and is carried down to the bone dividing the periosteum. This membrane is then separated from the bone with a curved raspatory until the bone has been denuded all round. The intercostal vessels, being separated with the periosteum, will not now be in danger of being wounded. About an inch of the rib is removed with strong cutting forceps. The periosteum on the inner surface of the rib, and the pleura, are then incised by an oblique incision running parallel with the ribs, and the pus evacuated. An india-rubber tube of large size, with a shield attached to the end of it, is introduced, and the wound partially closed at either extremity with a silkworm-gut suture. The tube need only be sufficiently long to fully enter the pleural cavity; a longer tube unnecessarily presses upon and irritates the lung. The wound should be dressed with a thick layer of some absorbent material, of which wood-wool impregnated with corrosive sublimate is probably the best, into which the pus discharges itself. When it has been determined not to excise a portion of rib, the incision is made along the upper border of the sixth rib, and the dissection is carried down to the pleura, which is then opened and the pus allowed to escape. It is not desirable to irrigate or wash out the cavity, unless the pus becomes foul and fœtid, as several cases have been recorded where sudden death has followed this practice. If it becomes necessary to wash it out, the rules mentioned on page 786 must be attended to.

When the operation is performed early, the lung generally expands, the cavity contracts, the discharge of pus ceases, and the wound closes; but when the operation has been delayed too long, or in some very chronic cases the lung becomes covered with a thick membranous layer of scar-like tissue which prevents its expansion, a cavity remains, and the opening is persistent, discharging a variable amount of pus. When this is the case, Estlander's operation should be performed. This consists in removing portions of several ribs, in order that the walls of the cavity may collapse, and this should be done as soon as it becomes evident that no further natural obliteration of the cavity can take place. The amount of rib removed must depend to a great extent upon the size of the cavity which it is desired to close. The operation may be either performed by making one large flap which corresponds with the shape and extent of the cavity, and contains any muscles which cover the chest; or a number of smaller flaps, corresponding to the number of ribs requiring partial excision. Whichever plan is adopted the ribs are exposed, and the exposed portion removed, with its periosteum, by cutting it through at either extremity with cutting bone forceps. The pleura is then to be incised, and by some it is recommended that as much as possible of the thickened membrane should be removed; the cavity is scraped and washed out to remove all degenerated tissue, the flap or flaps are replaced, and the remains of the walls of the cavity are allowed to fall as much as possible in contact, and are then dressed with gauze and firmly bandaged. The operation is one which is often attended with a considerable amount of shock and is followed by great deformity.

Operations on the lung.—Pneumotomy, or incision of the lung, has been mainly performed for two different affections. 1. The cases in which it is especially called for and has yielded the most satisfactory results, are those of hydatid disease of the lung. In Australia, where hydatids are very common, treatment by incision and drainage has been followed by great success, and ought always to be resorted to in preference to aspiration or the injection of iodine or other stimulating fluids. 2. In gangrenous abscess of the lung, incision and drainage have also been followed with a considerable measure of success. The cases best suited for it are those in which the gangrene is at no great distance from the chest wall, and the lung adherent to the costal pleura. In these incision and the insertion of a drainage tube give great relief, as the offensive secretions are no longer locked up in the lung.

Pneumotomy has also been performed for tuberculous abscesses and in cases of bronchiectasis, where it is believed that the dilatation is confined to one bronchus, but so far without any material benefit.

The operation is performed by raising a flap and removing a portion of one or two ribs. If the pleural cavity is obliterated, the lung is incised with a Paquelin's cautery, and a drainage tube inserted. If, on the other hand, the two surfaces of the pleura are not adherent, and the case is not urgent, the lung should be connected to the parietal pleura by a few points of suture, and the completion of the operation deferred for a couple of days, until adhesions have taken place.

Pneumectomy, or excision of a portion of the lung, has been performed in a few instances; but the only cases in which it is likely to be required are those already described, when a portion has become prolapsed through a hole in the parietes (page 781).

WOUNDS OF THE HEART AND LARGE VESSELS

Wounds of the pericardium.—The pericardium may be wounded by a stab or broken rib, or may be bruised or torn by a severe blow on the chest, without the heart being injured. It is attended with marked collapse and cardiac failure, followed by inflammation. At first friction sounds may be heard, but effusion soon takes place, and there is an increased area of pre-cordial dullness, and the heart sounds are muffled or inaudible. There is intense thoracic oppression, with orthopnœa and dyspnœa, restlessness, pallor, a frequent feeble pulse, and coldness of the extremities. In some cases blood is effused into the sac of the pericardium from a wound of some vessel of considerable size; then the increased area of cardiac dullness is present from the first, without any antecedent friction: the heart sounds are feeble and indistinct, and the impulse scarcely to be felt. The most serious cases are those in which the injury to the pericardium is complicated with an external wound, because there is the danger of septic infection.

The **treatment** consists in guarding against infection of the wound by antisepsis; in keeping the patient at rest; and if effusion ensues, and is causing serious symptoms of pressure, in tapping and draining the pericardium.

Wounds of the heart are often immediately fatal, but not necessarily so. They may be non-penetrating, that is, they may involve the substance of the ventricle without perforating the cavity; under these circumstances they may prove fatal from shock or from hæmorrhage, if one of the coronary arteries has been injured; or from pericarditis; or, on the other hand, the patient may recover. Or wounds of the heart may be penetrating, opening one of the auricular or ventricular cavities; they are then almost invariably fatal from loss of blood (figs. 302 and 303), the period at which death takes place varying with the size of the perforation and the rapidity with which the blood is poured out.

Symptoms.—If the wound is immediately fatal, the patient either falls at once prostrate or starts up convulsively, uttering a sharp and piercing shriek, and then falls dead. If, on the other hand, the wound is small and the blood escapes more slowly, there is intense collapse; great distress, with a pallid and anxious countenance; restlessness; dyspnœa; the action of the heart is tumultuous, weak, and irregular; the pulse scarcely perceptible, and the heart sounds obscure or inaudible. If the patient survives, signs of pericarditis supervene.

Treatment.—Until recently, wounds of the heart were regarded as beyond surgical treatment; but the recent experience of Dr. Parrozzani, of Rome, would seem to show that something may at all events be attempted in those cases which are not immediately fatal. A man who had been stabbed in the left side was admitted into hospital under the care of Dr. Parrozzani in a collapsed condition, with a scarcely perceptible pulse. An operation was performed at once. A flap comprising the whole thickness of the thoracic wall, and including portions of the fifth, sixth, seventh, and eighth ribs, was turned inwards. The left pleural cavity was opened and found to be full of blood, and an opening an inch in length was seen in the pericardium. This was enlarged, and a stab in the left ventricle was found to have perforated the wall and entered the cavity. A finger could be passed through it into the cavity of the ventricle. The wound was closed with four sutures, then the pericardial wound was closed, and finally the external incision. The patient recovered completely. Considering that these wounds are almost always fatal, an attempt should be made to follow in Dr. Parrozzani's footsteps, in the hope that a like success might attend the effort.

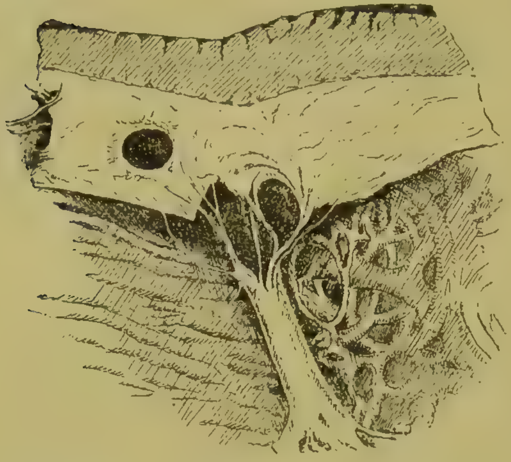
FIG. 302.—Gunshot wound of the heart. (From the Museum of St. George's Hospital.)

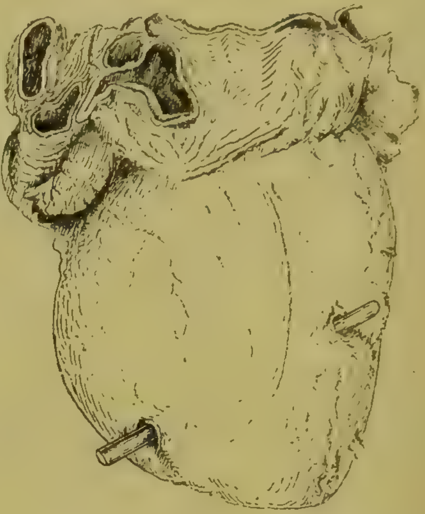
FIG. 303.—Punctured wound of the heart. (From the Museum of St. George's Hospital.)

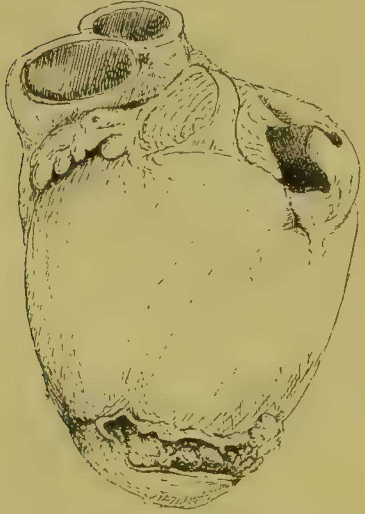
FIG. 304.—Rupture of the heart. (From the Museum of St. George's Hospital.)

Rupture of the heart, without external wound, occasionally occurs from severe blows or contusions of the chest wall. It is followed by instantaneous death (fig. 304).

Paracentesis pericardii may be required in cases of pericardiac effusion, which has resisted medical treatment, where signs of cardiac distress, such as cyanosis, dyspnœa, and epigastric pain, are present. The operation is usually performed in the fifth or sometimes the fourth intercostal space, about an inch from the sternum, so as to avoid wounding the internal mammary artery. It has also been done, where there is much distension in the fourth or fifth space, in the left nipple line, and this position is thought to afford better drainage; or it may be done on the right side. The skin having been rendered aseptic, an incision is made in the spot selected, and a carefully sterilised hydrocele trocar and cannula are inserted for about two inches in a direction upwards and outwards, so as to avoid wounding the heart. As soon as all the fluid has been removed, the cannula is withdrawn and the puncture sealed with gauze and collodion. Sometimes the fluid may prove to be pus, and some indication of this will be afforded by the temperature, the occurrence of rigors and superficial œdema. Under these circumstances the pericardium must be incised; a narrow bistoury is introduced, guided by the cannula, and along this a pair of dressing forceps, with which the wound is dilated. When the pus has escaped, a drainage tube is inserted and the dressings applied.

DISEASES OF THE CHEST WALL

Diseases of the chest naturally fall under the care of the physician; but there are certain diseases of the parietes of the thorax to which allusion must be made.

Tuberculous periostitis of a rib is a common affection in children and young adults, and usually runs on to the formation of a chronic abscess. An indolent circumscribed swelling appears on the chest wall, without pain or any active symptoms. On incising it, curdy pus will escape and the abscess cavity can be traced down to diseased bone, which is almost always situated on the internal surface of the rib. The only satisfactory treatment for these cases is to excise the portion of rib which is involved, as it is impossible, the disease being on the internal surface, to thoroughly scrape it and get rid of all the tuberculous material.

Syphilitic periostitis and gumma of the sternum and ribs are also common affections. They must be diagnosed from the tuberculous condition by the age of the patient, the history and by the presence of other evidences of syphilis. The condition is to be treated like other tertiary affections, with iodide of potassium in full doses; and the result of the treatment will serve to distinguish them from sarcoma, for which they may be mistaken.

Lipomata are very commonly situated on the chest, but when they grow from the subcutaneous tissue they resemble fatty tumours in other situations, and require no special description. There is, however, another form of lipoma, which grows from the sub-pleural tissue and protrudes outwards through an intercostal space. These resemble much the chronic abscess of tuberculous disease, from which they are difficult to distinguish until they are incised. They will then be found to consist of a mass of fat attached by a pedicle which passes inwards between two ribs. The pedicle should be ligatured and the tumour removed.

Chondroma of the ribs.—Cartilaginous tumours occasionally grow from the ribs, especially their anterior part, at their junction with the costal cartilage. They have also been described as growing from the site of an old fracture. They may consist of pure chondromatous tissue, but are more often fibro-chondromata, myxo-chondromata, or chondro-sarcomata. They form lobulated sessile tumours, fixed to the ribs, and are of firm consistence. They grow slowly at first, and then more rapidly. They should be removed, with the portion of rib from which they grow.

Malignant tumours of the chest wall may be either carcinomata, when they are secondary to cancer in other situations, more especially the breast; or sarcomata, when they are primary growths affecting the sternum and ribs. They are usually of a very malignant type, grow rapidly, and speedily disseminate in other organs. It is only in the very early stages that these growths can be removed with any prospect of non-recurrence.

CHAPTER XIII

INJURIES AND DISEASES OF THE ABDOMEN

Contusions of the abdominal wall. — Contusions of the abdominal wall are serious in proportion to the extent and depth of the tissues involved. A large number of them follow the course of like injuries elsewhere, and terminate without serious inconvenience. They may be attended with subcutaneous laceration of a vessel of considerable size, when a hæmatoma or large extravasation of blood will take place, which may descend into the scrotum and thighs ; or they may be complicated with rupture of one of the muscles of the abdominal wall, especially the rectus.

The **symptoms** are those of contusions elsewhere, swelling, discolouration, tenderness, pain, and shock. The shock is a very uncertain symptom. Some patients, after an injury to the abdomen, may present but little signs of shock, and yet the injury may be complicated with the rupture of some viscus ; while in others the shock is alarming and profound, and yet the patient recovers in a few days without any untoward symptom. Indeed in some cases the shock is so severe that it may destroy life without the appearance of any gross lesion after death. Death is said to be due in these cases to concussion of the solar plexus. When a muscle is torn, the retraction of the muscular fibres gives rise to a gap, which becomes filled with blood. This injury, after recovery, leaves a weak spot in the abdominal wall, through which a ventral hernia may subsequently protrude (see fig. 347). Where considerable extravasation has taken place into the abdominal wall, suppuration and abscess is liable to follow, and the matter is apt to burrow in the loose cellular tissue under the tendinous planes. When evacuated, it is often fœtid and suggestive of the presence of the bacillus coli communis.

Peritonitis of a local character sometimes follows contusions of the abdominal wall, without injury to the abdominal viscera ; this is believed by some to be due to laceration of the parietal peritoneum, but there is no evidence to prove that this is so, and it is probable that laceration of the parietal peritoneum, without injury to the viscera, is comparatively rare.

Treatment.—The patient should be kept absolutely quiet on his back, with a pillow under the knees to relax the abdominal wall. Opium should be given to relieve pain, and the patient kept on a fluid diet and watched. A guarded prognosis should always be given. If the shock is severe, the usual remedies for this condition should be applied (page 40).

Injuries of the abdomen attended by rupture of the viscera.—Injuries of the abdomen are often associated with rupture of one or more of the viscera, or of laceration of one of the large blood-vessels. The sufferer may die at once from shock, or in the course of a few hours from hæmorrhage, or later on from peritonitis.

Etiology.—Rupture of the abdominal viscera is especially liable to occur where there is a sudden localised blow on the abdomen, especially if the blow is given while the body is in the stooping position, and the abdominal muscles therefore relaxed and unable to contract and thus form a protection to the contained viscera. Thus rupture of one of the abdominal viscera is a common injury in farriers, who, stooping down to shoe a horse, receive a severe kick from the animal. They also occur from the passage of the wheel of a cart or carriage over the body, or from the abdomen being squeezed between the buffers of two railway trucks. The hollow viscera are more likely to be torn when they are full; thus the stomach is ruptured shortly after a hearty meal, or the bladder when the patient has not passed water for some time.

Symptoms.—The symptoms vary very greatly, not only with regard to the viscus injured, but also as regards their general characteristics. There is usually severe shock; yet, on the other hand, there may be cases in which shock is almost, if not quite, absent. A patient with a ruptured intestine or lacerated liver may walk into the hospital without any of those symptoms which, as a rule, lead one to suppose that such a serious injury has taken place. In the majority of cases, however, the shock is marked: coldness and pallor of the surface; a small and feeble pulse, which is sometimes scarcely perceptible; subnormal temperature, and shallow, gasping respiration. There is anxiety and distress of countenance, and great depression of the vital powers. Pain is complained of at the seat of injury, and is sometimes very intense. It is continuous, and is often spoken of as of a burning character. Vomiting—first of the contents of the stomach, and subsequently of a bilious fluid—is generally present. There is often dullness, from extravasated blood over the seat of injury.

In those cases where there is great loss of blood, as in cases of rupture of the liver and spleen, and death is threatening from hæmorrhage, the patient begins to present the characteristic signs of loss of blood. He is restless, turning from side to side; he complains of intense thirst; the extremities become cold, the lips blanched, and he gradually sinks into a state of unconsciousness and dies. If, on the other hand, peritonitis is set up, as occurs most frequently in rupture of the hollow viscera, the pain becomes still more acute, the vomiting persistent, and the abdominal wall hard and resistant, like a board.

Rupture of the stomach.—The stomach is not often ruptured, on account of its comparatively protected situation. When it is, the laceration may be incomplete and not involve the peritoneal coat, but is more often complete, and is attended by the leakage of its contents into the abdominal cavity, especially as the viscus is almost always full; rupture only occurring when the organ is distended after a hearty meal. There is almost always shock, accompanied by intense pain, at first localised to the seat of injury, but rapidly spreading over the whole abdomen, the parietes of which become hard and rigid. Vomiting is rarely persistent, but some of the contents of the stomach are often ejected shortly after the accident, and the vomited matter will probably be mixed with blood. There is usually resonance over the area of hepatic dullness, from the presence of free gas in the peritoneal cavity, which in the first instance has found its way there through the rent in the stomach, but later on may be the gases of decomposition. Cases of complete rupture of the stomach are almost uniformly fatal, unless subjected to operative interference, and death usually takes place within forty-eight hours from peritonitis.

Rupture of the intestine.—Rupture of the intestine is usually produced by a smart, sharp blow, and is influenced to a great extent by the degree of its distension. It is usually stated that the portion of the intestine most commonly ruptured is the jejunum, then the ileum, then the duodenum, and lastly the colon; but from a consideration of the anatomy of the intestine, it would seem that the transverse portion of the duodenum is the part that ought to be most frequently injured, as it is more or less fixed and cannot float out of the way of a blow like the rest of the gut, and moreover it rests on the hard and rigid bodies of the vertebræ, against which it would be compressed in the event of a blow being inflicted upon it. Against this, however, it may be said that it is in a somewhat more protected situation under the left lobe of the liver. The rupture may be complete—that is to say, the bowel is separated into two pieces (fig. 305)—but in the majority of cases is incomplete. In some cases there are no symptoms of any marked character for a few hours; but as a rule there is evidence of shock from the first, with intense burning pain over the abdomen and persistent vomiting, first the contents of the stomach being rejected; then a bilious fluid, often mixed with blood, and sometimes, in the later stages, fæculent matter. The pulse is feeble and intermittent; the countenance betokens great anxiety; there is much thirst; rigidity of the abdominal wall, with perhaps tympanitis, and in many cases retention of urine. There may be emphysema of the abdominal wall, from escape of flatus. This sign, if present, is of great diagnostic value, but it is rarely met with. Cases of rupture of the intestine are almost always fatal if left to themselves, death occurring from shock or peritonitis; or at a later period, if the patient survive so long, from obstruction.

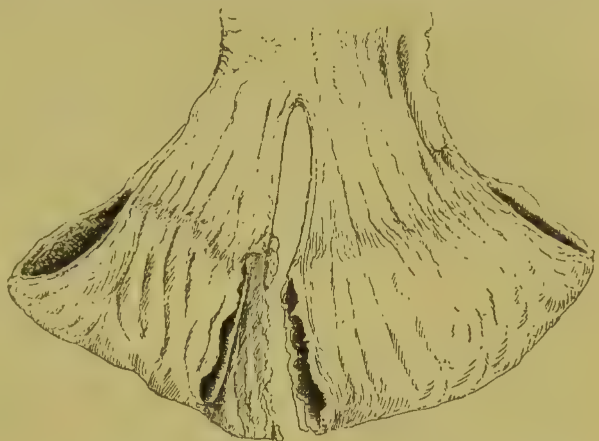
FIG. 305.—Complete rupture of the intestine. (From the Museum of St. George's Hospital.)

Treatment.—In cases of rupture of the stomach and intestine, if the diagnosis is established, or even if there are reasonable grounds for believing that one of these injuries has taken place, a laparotomy should be performed, and the sooner it is done the better chance the patient will have of recovery. Even a very considerable amount of shock ought not to deter the surgeon, though if it is very profound it may be perhaps desirable to wait and endeavour to rally him before proceeding to operation.

In at least 95 per cent. of cases, rupture of the stomach or intestine proves fatal, and an exploratory operation, even though no rupture is found, is a lesser evil than delaying the operation until the diagnosis is made certain by the advent of symptoms of diffuse inflammation. The incision is best made in the middle line; in cases of ruptured intestine the level of the incision being indicated by the situation of the blow. When the peritoneal cavity has been opened, the laceration must be sought for, and when found brought up to the surface of the wound.

If the stomach is injured, this viscus should be emptied of its contents, if it contains anything, by gently squeezing it, and the rent repaired. This is done, if there is not much bruising or laceration of the edges of the wound, by uniting them by a Czerny-Lembert suture, which consists in joining the mucous surfaces of the rent with a continuous suture, and then bringing the serous coat on either side of the rent in apposition by an ordinary Lembert's interrupted suture. This suture is applied in the following way. The needle is introduced into the serous coat on one side of the laceration and some little distance beyond its extremity, and made to penetrate to the submucous coat and then emerge again. It is now carried across the line of the rent and reintroduced into the submucous tissue, and made to emerge at a point a little more external to the laceration. In this way a series of sutures are applied, at the distance of about an eighth of an inch from each other, until they extend well beyond the other extremity of the rent (fig. 306). In applying these sutures care must be taken not to perforate the mucous coat, otherwise leakage may take place. By drawing up and tensing these stitches, the margins of the wound are tucked in and the peritoneal surfaces around the rent are brought into apposition. They are then tied. It will be seen that in this way a groove is formed, and it is generally a wise precaution to insert an extra stitch at either end, so as to completely close the terminal extremities of the groove. After the rent has been closed, the abdominal cavity must be carefully cleansed of all extraneous matter with sponges, and by irrigation with sterilised water or a normal saline solution of a temperature of 100° to 105° F., care being taken to get rid of all the surplus water before the abdomen is closed, for, having been mixed with putrescible matter, it may be more or less septic, and if left behind likely to set up mischief. If the edges of the wound are much lacerated and torn, it may be advisable to excise them; but this proceeding materially prolongs the operation, which it is desirable should be completed as rapidly as possible, on account of the condition of the patient, and is often attended with considerable hæmorrhage. If the rent is on the posterior surface of the stomach, the difficulties of the operation are greatly enhanced. An attempt must be made to reach the seat of injury by division of either the layers of the great omentum as it passes from the stomach to the transverse colon, and thus opening up the lesser cavity of the peritoneum, or by dividing the gastro-hepatic omentum.

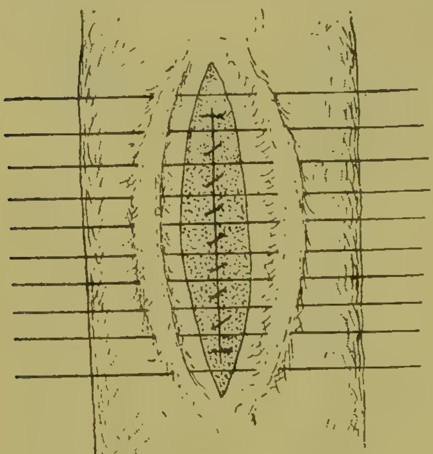

FIG. 306.—Czerny-Lembert suture.

When the injury is in the bowel, one of several plans will have to be pursued according to the amount of injury which has been done to the intestine. If the wound is clean-cut and is not extensive, the perforation may be closed by a single layer of Lembert's suture; but if the edges are torn and jagged, though the wound is not extensive it is better to excise them and bring the parts together by the Czerny-Lembert method. In those cases where the wound is extensive and the gut around is much bruised, or where there are several wounds, or the gut torn completely apart and its edges lacerated, enterectomy or excision of the involved segment of the bowel should be performed and an end-to-end anastomosis made. Formerly it was recommended that in those cases where the patient was suffering from severe shock, and it seemed probable that he would not survive a protracted operation, an artificial anus should be made in order to save time. In the present day, with our improved methods of operating, a resection and end-to-end anastomosis can be done almost as rapidly as an artificial anus can be made, and there can rarely be any necessity for resorting to such a proceeding, which either leaves the patient in a very distressing condition, or necessitates the performance of another operation at some future date.

The operation of **enterectomy**, or resection of a portion of gut, may be required in cases of gangrenous gut; intussusception; for the removal of stricture; and in dealing with artificial anus; in addition to those cases where it is required for injury. It is performed as follows. The abdomen having been opened, and the amount of bowel to be removed having been determined upon, the gut must be carefully clamped at some distance on either side of this portion in order to prevent the escape of any of the contents of the bowel during the operation. Many forms of enterectomy clamps have been devised by different surgeons, but probably the simplest method of attaining the end, and as efficient as any, is to make a small opening in the mesentery, at the spot at which it is desired to compress the gut, and passing a piece of india-rubber tubing through the opening, encircle the bowel with it, with sufficient tension to arrest the passage of fluid through the canal without strangling its walls, and fixing the tube with a pair of clip forceps. This having been done, the injured portion of bowel is to be separated above and below with scissors. If the portion removed is small, it may be simply separated from the mesentery at its attachment, and any bleeding vessels tied with catgut; but if the portion removed is large, it will be necessary to take away a V-shaped piece of the mesentery, having first secured the main vessels in the part to be removed before the section is made. All hæmorrhage having been arrested, the cut edges of the mesentery, if any has been removed, are now sutured, and the surgeon then proceeds to unite the cut ends of the bowel by the operation of end-to-end anastomosis, or enterorrhaphy as it is termed. There are numerous ways in which the divided ends of the bowel may be united, and they may be classified into two groups: (1) where the operation is performed by simple suturing, and (2) where the union is effected by some special apparatus.

Enterorrhaphy by suturing.—The following are some of the principal methods which have been adopted.

(*a*) The ends of the bowel may be united by the Czerny-Lembert suture above described. The operation is, however, an exceedingly tedious one, and on account of the time it takes in its performance it is rarely employed. Moreover, there is some difficulty in dealing in this way with the part of the bowel adjacent to the mesenteric attachment. If this is so, the operation may be slightly modified by what is known as Wölfer's method (fig. 307), that is to say, about a third of the calibre of the bowel in the neighbourhood of the mesenteric attachment is sutured from within. The sutures are first passed through the muscular and then the serous coat of one piece of the gut, and through the serous and then muscular coat on the other piece, and the knot tied on the inner or mucous surface. In this way sutures are applied to about a third of the circumference of the gut, and then the mucous coat is brought together by a second row of sutures over the first knots. The rest of the circumference is united by the Czerny-Lembert method.

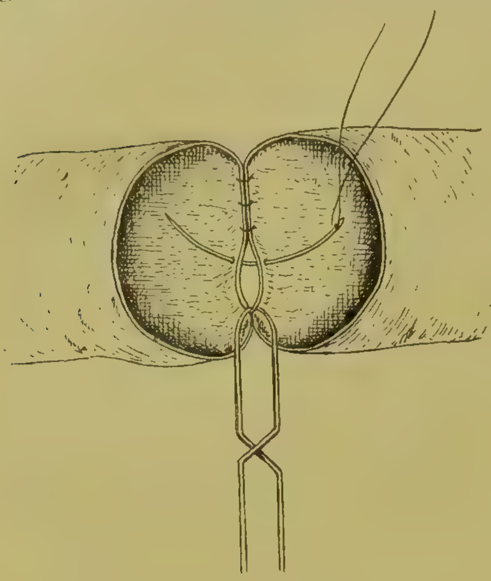

FIG. 307.—Wölfer's suture.

In all instances in which an end-to-end anastomosis by the Czerny-Lembert method is performed, this modification of Wölfer should be adopted, as in the neighbourhood of the mesenteric attachment a leakage is very apt to occur if the Czerny-Lembert method is employed throughout.

(*b*) **Jobert's method.**—This consists in invaginating one portion of the bowel into the other. The cut extremity of the lower end of the bowel is turned down into the tube for about half an inch. A long suture is then passed from the outside of the bowel through its coats and through the inverted portion, close to its free extremity; secondly, it is passed from the mucous surface through the coats of the upper end of the bowel about half an inch from its free border, and finally again through the inverted layer of bowel, but this time from the inside of the gut and somewhat nearer the bend. A similar suture is applied on the opposite side (fig. 308). By tightening the free ends of these two sutures the upper end of the divided intestine is drawn downwards and becomes invaginated into the lower, and is fixed there by tying the two ends on either side together. A series of superficial sutures are now applied all round the circumference of the bowel through the serous coat, at the angle where the two portions of gut come together (fig. 308, B).

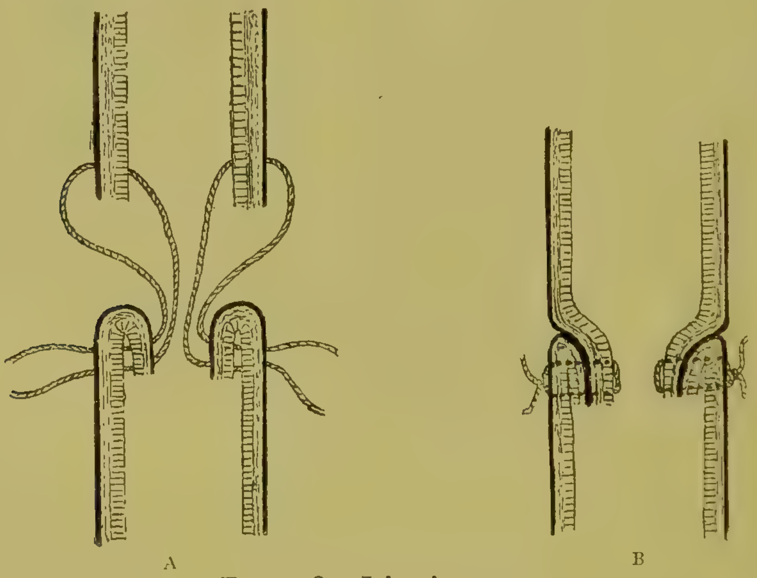

FIG. 308.—Jobert's suture.

(*c*) **Maunsell's method.**—This method of end-to-end anastomosis is by many surgeons regarded as the best, and the one which gives the most satisfactory results. The two ends of the bowel are first brought together by two sutures passed through all the coats, one at the mesenteric attachment, and the other exactly opposite to it. The ends of these sutures are left long. An incision is now made in the upper segment of the gut, opposite the mesenteric attachment, commencing about an inch from its divided end, and carried upwards in the axis of the bowel for about an inch and a half. The ends of the suture are passed between the divided ends of the bowel, up the lumen of the tube and out of the vertical slit, and then by gentle traction the divided ends (fig. 309, B) are invaginated and drawn out of the artificial opening (fig. 309, A). A long straight needle armed with horsehair is now passed through both sides of the protruding bowel about a quarter of an inch from its free margin, care being taken to include all of the coats of the intestine (fig. 309, *a*, *b*). The suture is then picked up as it crosses the lumen of the tube, divided, and the halves tied on either side. From sixteen to twenty sutures are now applied around the tube, and the two ends securely sutured together, with their peritoneal surfaces in contact. All the sutures are cut off short, and by gentle traction on the lower segment the invagination is reduced. Finally, the longitudinal wound which has been made in the gut is closed by Lembert's suture. If there is any doubt about the line of suturing, a row of Lembert's sutures can be applied around the circular junction, so as to sequestrate it; for it must be remembered that the sutures forming the circular junction penetrate all the coats of the gut, and there may be some risk of leakage.

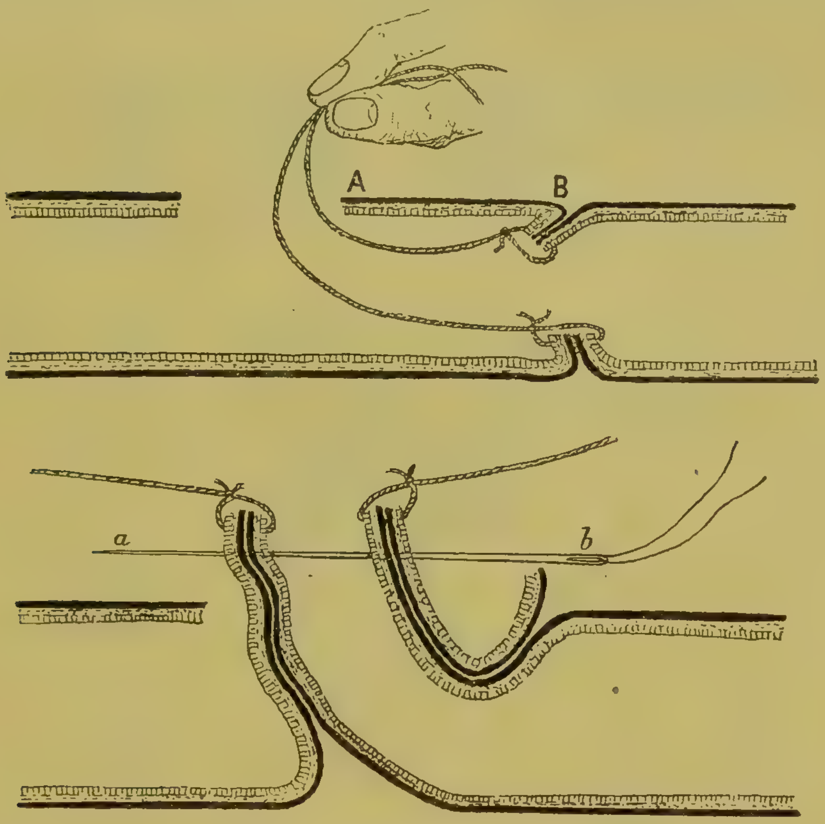

FIG. 309.—Maunsell's suture.

In cases where it is necessary to unite two unequally sized pieces of intestine, as, for example, the large intestine to the small, the opening in the larger gut is first reduced in size by suturing a portion of it with a Czerny-Lembert suture, until it corresponds to that of the smaller. The operation is then proceeded with as before, by invaginating the smaller gut through an opening made in the larger.

(*d*) **Cheatle's method.**—Another plan of performing end-to-end anastomosis has been recently introduced by Cheatle, which appears to me to possess the advantage of great simplicity, though I have no personal experience of it myself. After the resection of the injured or diseased portion of the bowel, a longitudinal incision is made in each end of the divided intestine, opposite the mesenteric attachment. The length of this incision should be equal to the diameter of the tube at the point of resection, and it should go through all the coats of the bowel (fig. 310, A).

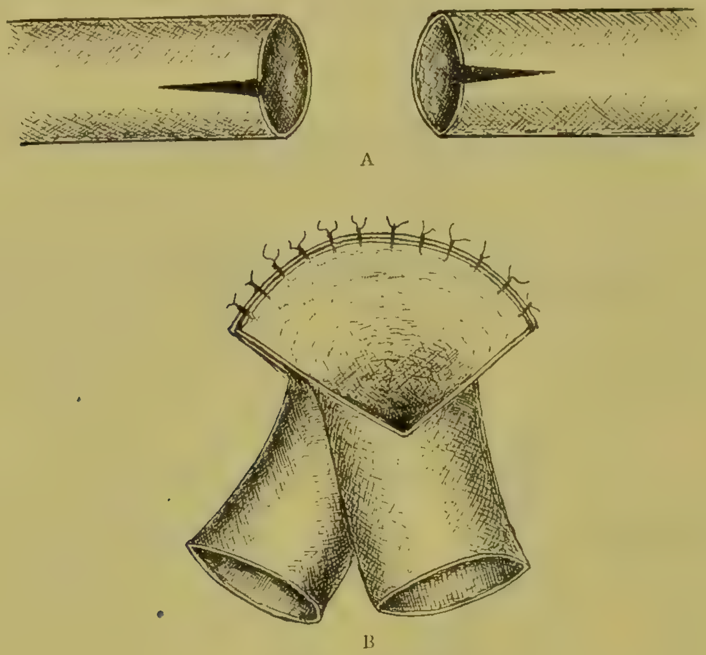

FIG. 310.—Cheatle's suture.

The divided ends of the intestine can now be spread out in the form of a fan, and while they are in this position they are placed back to back, so that the two serous coats are in apposition (fig. 310, B). An assistant holds them in this position, with the edges of the two segments of the gut exactly level, and they are rapidly sutured together, care being taken to pick up all the coats of the bowel with each stitch, which should be inserted about a quarter of an inch from the free margin. Cheatle recommends that the first suture should be inserted at the point of the mesenteric attachment, and the next two at the respective extremities of the edge of the fan-shaped expansion, so as to accurately adapt the borders to each other. The joined gut is now to be straightened out, and the longitudinal incision sutured by Lembert's method. The large intestine can be joined to the small in the same way. After the junction of the two portions has been effected, there will be left a superfluous flap of the large gut on either side. These are to be cut away by a V-shaped incision, so that the apex of the V is exactly in a line with the preliminary incision into the free end of the small intestine, and the edges sewn up by Lembert's suture.

Several other methods of end-to-end anastomosis have been introduced, but space will not allow of my describing them. It must be mentioned, however, that some surgeons prefer to join two portions of severed gut by a lateral opening rather than end to end, for the following reasons: (*a*) A greater surface of peritoneum can be brought into contact without

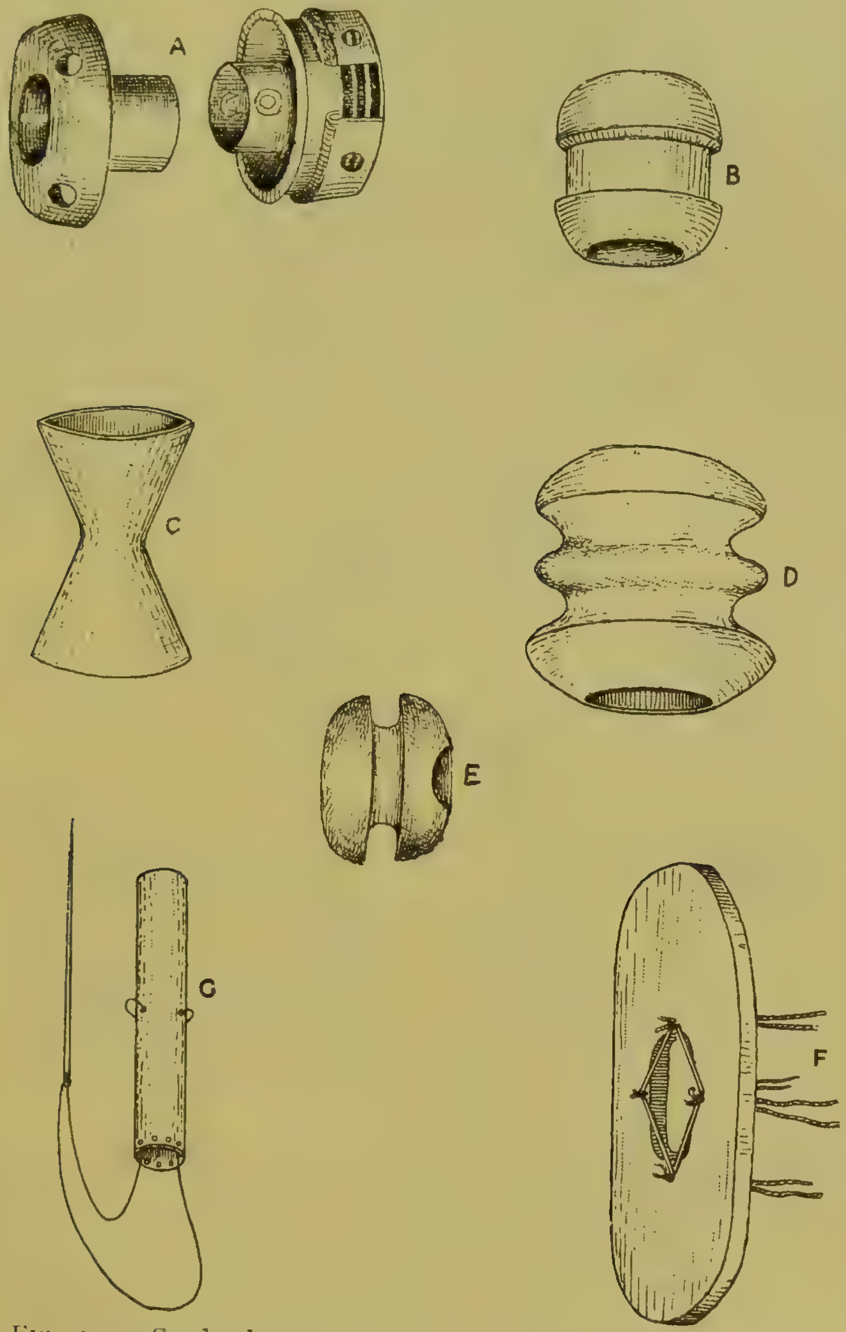

FIG. 311.—Sundry buttons and bobbins for intestinal anastomosis. A, Murphy's button; B, Mayo Robson's bobbin; C, Allingham's bobbin; D, Hayes' bobbin; E, Ball's bone ring; F, Senn's plate; G, Paul's decalcified bone tube.

diminishing the lumen of the tube. (*b*) Intestines of unequal size can be more readily joined. (*c*) The opening can be made larger. (*d*) The vascular supply at the seat of junction is better, for it is supplied by the vessels of the mesentery which encircle the gut, instead of the small vessels which supply just the portions of bowel joined together. The mode of performing lateral anastomosis will be described at a future page.

Enterorrhaphy by means of special apparatus.—Many different forms of apparatus have been invented for facilitating the junction of two pieces of intestine either by end-to-end or lateral anastomosis. Among these may be mentioned (*a*) Murphy's button; (*b*) Mayo-Robson's bobbin; (*c*) Paul's tube; (*d*) Allingham's bobbin; (*e*) Ball's bone ring; (*f*) Hayes' bobbin; (*g*) Senn's plates; (*h*) vegetable absorbable plates (fig. 311). It will be impossible to describe all these various special appliances, and it will probably be sufficient if we describe Murphy's button, merely mentioning with regard to the others that they are all composed in whole or in part of decalcified bone, which causes no irritation to the mucous surface with which it is in contact, and becomes soft and pulpy in a few days and finally disappears. With regard to Paul's tube and Hayes' bobbin the anastomosis is performed by a process of invagination, and the main object of this special appliance is to facilitate the introduction of one portion of the intestine into the other.

Vegetable absorbable plates are usually fashioned like Senn's plate, and are cut out of a potato or a turnip. They have been strongly recommended by American surgeons, and certainly possess the advantage that they are easily procurable. They quickly soften and become absorbed when no longer needed.

Murphy's button consists of two parts, male and female. Each part consists of a central tube, through which the fluid contents of the intestine can pass when the instrument is in situ. To the end of each of these tubes is attached a cup-shaped expansion. The male tube is rather smaller than the female, into which it can be inserted, and when this is done it is retained in position by a spring which catches against a screw thread with which the female tube is lined, so that the two portions can only be separated by unscrewing. The male expanded portion is fitted with an inner flange, which is movable on the outer cup and is governed by a spiral spring, so that when the button is in position the rounded margins of the two cups are pressed closely together, and any tissue lying between them is subjected to pressure.

In performing end-to-end anastomosis with Murphy's button, a running thread is inserted along the excised edge in the manner shown in fig. 312. It is begun at the part of the gut opposite the mesentery and carried in and out down to the mesentery. Here a return stitch is taken (see fig. 312), and the suture is then continued along the opposite side to the point from which the start was made. The button is inserted by seizing the end of the central tube in a pair of clip forceps, and pushing the button into the lumen of the tube. The puckering string is then drawn tightly around the tube and tied, so that the bell-shaped expansion is inclosed with the gut, and only the central tube projects. The other half of the button is introduced in the same manner and the two parts joined (fig. 312). The walls of the gut are now pressed together between the margins of the bell-shaped expansions, and pressure atrophy takes place, and eventually the button is set free. While, however, this has been taking place, union has occurred just external to the line of pressure atrophy, and by the time the button is free the two divided ends of the gut will be united.

Murphy's button is still regarded by some as the best means of performing end-to-end anastomosis, though it does not appear to retain all the favour which was at first bestowed upon it. Undoubtedly the great point in its favour is the rapidity with which it can be employed. But numerous unfortunate accidents have followed its use. Among these are the tendency which it has to remain in the bowel, sometimes without doing any harm, at others causing obstruction and perforation; in other cases there has been failure of union, or sloughing at the line of junction and extravasation of fæces; again, a case has been recorded where the button from its weight caused kinking of the gut and strangulation, and in a patient under my own care the lumen of the tube became blocked by a piece of potato skin which the patient had swallowed. It would seem, therefore, that it is better to join the two ends of the intestine by means of simple suturing, without the use of any appliance, and to reserve Murphy's button for those cases where the completion of the operation in the shortest possible time is a matter of urgent importance. It will generally be found, however, that the surgeon may be expected to attain the greatest success by using that method with which he is most familiar.

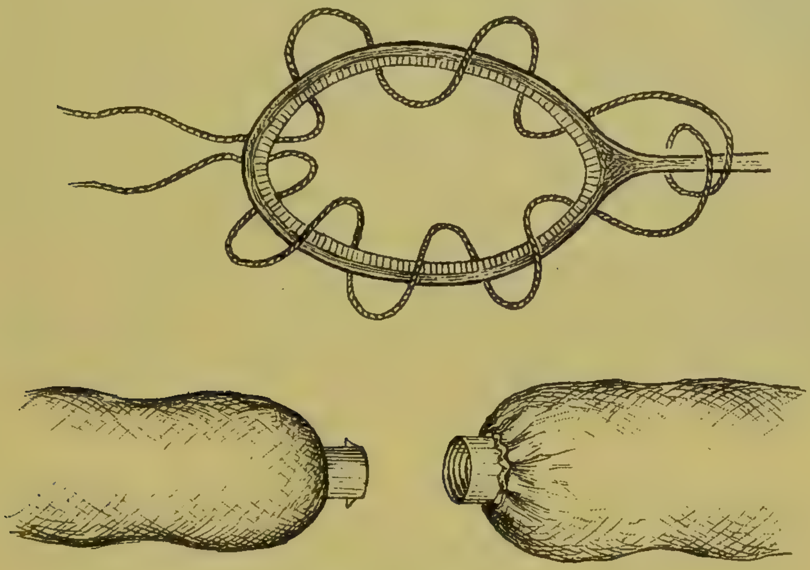

FIG. 312.—Mode of applying Murphy's button in end-to-end anastomosis.

The subject of end-to-end anastomosis cannot, however, be left without mentioning an important modification of Maunsell's method which has been suggested by Ullman. The first steps are identical with those adopted by Maunsell, but when the two segments of bowel have been pulled out of the lateral incision, he introduces into the tube a bobbin of decalcified bone and ties a silk thread round its centre, where there is a groove, inclosing the two tubes of gut; he then returns the bobbin and protruding bowel, and sews up the lateral opening. This materially shortens the operation, and would appear to combine rapidity with security.

Rupture of the spleen (fig. 313).—In rupture of the spleen the case very frequently terminates fatally on account of the exceedingly friable and vascular nature of the organ. It is especially liable to occur when the viscus is enlarged as the result of exposure to a malarious climate, and is often associated with fractured ribs. There is great shock, accompanied by the signs of internal hæmorrhage, with the history of an injury on the left side and probably a bruise in the left hypochondrium. There is a large fixed area of dullness on percussion in this situation from extravasated blood.

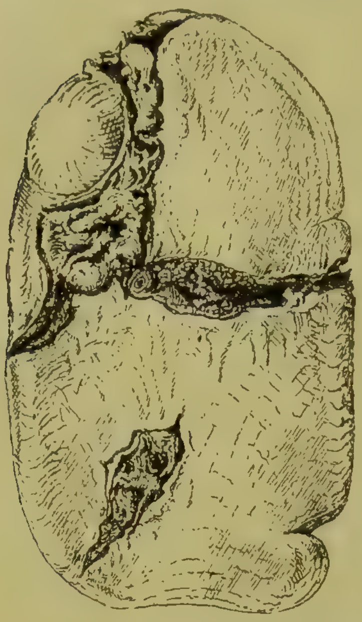

FIG. 313.—Rupture of the spleen. (From the Museum of St. George's Hospital.)

Treatment.—If the diagnosis is fairly clear that the spleen has been ruptured, the abdomen should be opened. If the wound in the spleen is small, an endeavour may be made to close it with silk or catgut sutures, but this is not always easy on account of the friable nature of the organ, so that in most cases, especially if hæmorrhage is still going on, it is better to stuff the rent with a long strip of iodoform gauze, the end of which is allowed to hang out of the wound as a drain. If the organ has been extensively damaged, it must be removed. Several successful cases of splenectomy for rupture have been recorded.

Rupture of the liver (fig. 314).—The liver is more frequently ruptured than any other of the abdominal viscera. This no doubt is due, to a great extent, to its large size and unyielding nature, but also to the easy lacerability of its structure. The **symptoms** are those of severe intra-abdominal injury, accompanied by the history of a blow over the region of

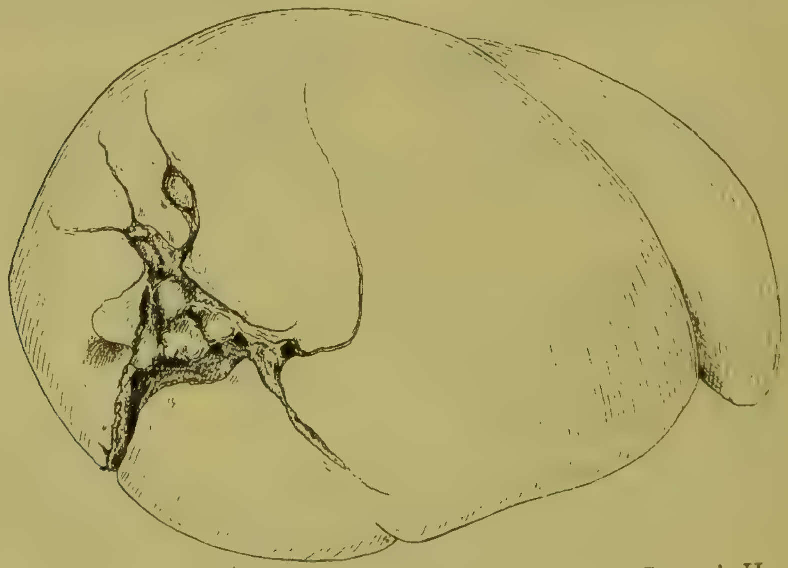

FIG. 314.—Rupture of the liver. (From the Museum of St. George's Hospital.)

the liver; a bruise in this situation and increased dullness on percussion from extravasated blood. The injury is not necessarily immediately fatal, and if the patient survive, it may be followed by diffuse peritonitis, bilious vomiting and white stools. Jaundice may occur at a later period.

Treatment.—If there are no signs of increasing hæmorrhage, the patient should be kept absolutely quiet, and if the pulse is feeble hypodermic injections of strychnia should be given. No alcohol or ether should be administered, as they tend to increase hæmorrhage. If there is evidence that bleeding is going on, the abdomen should be opened; the clots turned out, and the laceration, which is generally on the convex surface near the free border, sought for. If bleeding is still going on from the rent, it may be arrested by compressing the hepatic artery and portal vein by introducing one finger into the foramen of Winslow, and placing the thumb on the gastro-hepatic omentum and compressing the structures between the two. Any vessels which can be seen bleeding should be seized and tied, and the margins of the laceration brought into apposition and sutured by means of a curved blunt needle passed from one side of the wound to its bottom and out on the other side. All the sutures should be passed before any are tied, and this must be done with the greatest gentleness, as they are very liable to tear their way out. When the injury of the liver is extensive and it is not possible to bring the torn surfaces together, the rent should be packed with iodoform gauze, the end of which is allowed to hang out of the wound.

Injuries to the gall bladder.—The gall bladder or one of the biliary ducts may be ruptured. Of the latter the cystic duct is the one most commonly injured. These injuries are very difficult to diagnose, and death usually occurs from peritonitis. If the symptoms should lead to the performance of laparotomy, and a small rent is found in the gall bladder, it may be sutured, but if the injury is extensive it is safer to remove the whole organ. If the cystic duct is injured, its intestinal end must be closed and the gall bladder removed. In rupture of either of the other ducts all that can be done is to provide for efficient drainage, in the hope that a biliary fistula may form.

Wounds of the abdomen.—Wounds of the abdomen may be (1) non-penetrating or (2) penetrating. The latter may be complicated with protrusion or injury of the abdominal viscera.

1. **Non-penetrating wounds** may be incised, punctured, or lacerated and contused. They differ in no essential particular from wounds in any other part of the body, and the treatment is for the most part the same, except in those cases where the several planes of muscular fibre have been divided; here it is desirable to unite the muscles with buried sutures before the superficial structures are brought together, as these wounds are very liable to be followed by ventral hernia.

2. **Penetrating wounds** may be (*a*) simple, i.e. without injury or protrusion of the viscera; (*b*) complicated with protrusion; and (*c*) complicated with injury to the viscera, with or without protrusion.

(*a*) **Simple penetrating wounds.**—If the wound is narrow and oblique, it is not easy to say whether penetration has taken place or not. Sometimes it may be known by the escape of a little reddish serum, and the history of the injury and an account of the manner in which it was inflicted, with an examination of the weapon, may afford some clue; but if there is any doubt the wound should be carefully enlarged and a thorough investigation made. A little increase in the size of the wound will do no harm, and it would be a fatal mistake to overlook an injury to the intestine. In those cases where it has been definitely ascertained that penetration has taken place, but that there is no injury to any of the contained viscera, the wound is to be treated as a simple one. The skin around must be carefully cleansed, and the peritoneum first sutured, then the muscles, and finally the skin.

(*b*) **Penetrating wound with protrusion.**—The viscera which have the greatest tendency to protrude are the omentum and the small intestine. The protrusion is always large in comparison with the aperture by which it escapes, so that it speedily becomes congested and may even become strangulated. If left unreduced, it loses its polish and bright colour, and becomes dull and livid from congestion, and may eventually become black from gangrene.

The **treatment** will vary according to the condition of the protruded mass. If the wound has been recently inflicted and the protrusion is not much congested, it should be carefully cleansed with some weak antiseptic solution, as corrosive sublimate (1 in 4,000), and returned; the wound being enlarged if necessary for this purpose. If omentum is protruding, it is wiser perhaps under all circumstances to remove it, whether it is congested or not. If gut is protruding and it is slightly congested or bruised, it may still be returned, but it is a safe precaution to attach it to the margin of the wound by a single catgut suture, and not completely close the external wound but insert a drainage tube, so that if the gut gives way and fæces are extravasated, they may find their way out through the external wound.

c. **Penetrating wounds with injury to the viscera.**—In these cases the injured viscus may either protrude or not. When it does not there is often difficulty in knowing whether a viscus has been injured, unless fæcal matter, urine, or bile is seen escaping from the wound, and this is not common; the rule, therefore, laid down in speaking of penetrating wounds without injury must be rigidly carried out, of making a thorough examination, with enlargement of the wound if necessary. The great danger in these cases is septic peritonitis, and this will almost certainly occur if any of these fluids are extravasated and the case is not promptly dealt with by the surgeon. If the intestine has been wounded and the opening is small it may be closed by a Lembert's suture, and the abdominal cavity having been thoroughly cleansed the external wound may be closed. If, however, the gut is hopelessly damaged, the injured portion must be excised; or possibly, if the patient's general condition is very bad, an artificial anus may be made (see on this point page 797).

Gunshot wounds of the abdomen are formidable injuries belonging to this class—namely, penetrating wounds, where there is injury to the intestine without protrusion—and are almost universally fatal. The intestine may be perforated in two or more places by the bullet. In these cases, whether there is any definite symptom of injury to the viscera or not, the wound should be enlarged and the abdominal cavity freely opened and the extent of the injury ascertained.

DISEASES OF THE ABDOMINAL WALL

There is nothing special to be said about diseases of the abdominal wall in this place, except in regard to some affections of the umbilicus. Other conditions will be spoken of in their appropriate place; thus artificial anus and fæcal fistula will be described with diseases of the intestine, and ventral and umbilical hernia in the section devoted to the consideration of hernia.

Affections of the umbilicus.—Two forms of fistulæ, arising from congenital defect, are met with at the umbilicus. One of these arises from a want of closure of the omphalo-mesenteric or vitelline duct, and the other from a want of closure of the urachus.

1. **Vitelline duct fistula.**—The omphalo-mesenteric duct, the original communication between the portion of the yolk-sac which lies in the body cavity of the embryo and the portion outside, usually becomes obliterated, but it may remain pervious in whole or in part, and under these circumstances the vitelline duct fistula is formed. When it is pervious throughout it communicates by one end with the lower part of the ileum, and by its other forms a fistulous opening at the umbilicus, through which a small quantity of fæcal stained mucus is discharged; though in some cases where the lumen of the fistula is large a considerable amount of fæcal matter may escape. When the original duct is obliterated in part it is the intestinal segment of the tube which becomes impervious, and then there is merely a discharge of mucus from the fistulous opening at the umbilicus.

2. **Urachal fistula.**—This is the result of non-closure of the urachus, or upper part of the allantois, from the lower part of which the bladder is formed. The urachus is generally obliterated before the termination of fœtal life, and forms an impervious cord which stretches from the upper part of the bladder to the umbilicus. If it does not become impervious, a urachal fistula is formed, and the urine may sometimes escape from it in considerable quantities.

Treatment.—Sometimes these fistulæ close spontaneously, or their closure may be effected by a touch or two of the actual cautery. When this is not the case, in the complete fistulæ where fæcal matter or urine is discharged, they are probably incurable. Plastic operations have been tried for their relief, but without very satisfactory results. When they are incomplete they may be cured by excision, but it is questionable whether the operation is desirable, as the only inconvenience arising in these cases is the occasional discharge of a little bead of mucus. Other fistulæ, such as fæcal or biliary fistulæ, sometimes form at the umbilicus later in life. They must not be mistaken for the congenital variety.

Cysts are occasionally formed at the umbilicus as another result of imperfect development; either the omphalo-mesenteric duct or the urachus may become closed at both ends, and fluid may collect in a pervious intermediate portion. This may suppurate and give rise to abscess. They should be excised.

A **solid tumour** may also be found at the umbilicus, consisting of a red polypoid excrescence, which is composed of a number of tubular glands held together by connective tissue. It is believed to be the remains of the omphalo-mesenteric duct. It should be treated by removal.

In new-born infants erysipelas and rarely tetanus (trismus neonatorum) originate from want of cleanliness during the separation of the cord, and later on in life eczema is a by no means uncommon complaint from the same cause.

Epithelioma is occasionally met with at the umbilicus, and sometimes epithelioma of the bowel may lead to fæcal fistula in this situation.

PERITONITIS

Peritonitis, or inflammation of the serous membrane which lines the abdominal cavity, is a serious condition, which arises from many different causes, presents numerous different phases as regards its clinical symptoms, and is frequently the cause of death in abdominal cases. The condition has recently been studied and brought before the profession by Mr. Treves in his Lettsomian lectures. He has done much to clear up our knowledge of this formidable disease. The description which will be now given is mainly derived from this source.

Peritonitis may be acute or chronic. The acute form may be either general or local; the chronic may be simple or tuberculous.

Morbid anatomy.—In acute peritonitis the morbid processes are the same as in inflammation of other structures. There is first of all hyperæmia followed by exudation, and the nature of the exudation may vary. In some cases it may consist of plastic lymph. Under these circumstances, if the abdomen is opened, the coils of intestine, which have become dull and lustreless, will be found to be glued together by an opaque greenish grey material which principally occupies the sulci between the coils. If the patient lives, this fibrinous exudation may, at all events in part, become organised into cicatricial tissue, and the coils of intestine become firmly matted together by adhesions. In other cases the exudation is much more serous in its nature, and the peritoneal cavity is filled, to a greater or less extent, by a turbid, greenish yellow fluid, in which particles of flocculent lymph may be seen floating about. And finally in some cases the exudation may become purulent, and the abdominal cavity, in whole or part, filled with an offensive sero-purulent fluid. When the peritonitis is general or diffuse this exudation pervades the whole cavity; when, on the other hand, it is local or circumscribed, the effusion is shut off from the general cavity by adhesions taking place around it, and we may have a circumscribed collection of serous exudation or pus, the remainder of the cavity remaining normal.

In chronic peritonitis the pathological changes are the same, but take place more slowly. We may have the same pouring out of plastic lymph and formation of adhesions, or the same effusion of serum or sero-purulent fluid or true pus.

The causes of peritonitis.—Peritonitis depends entirely or almost entirely on infective processes, and is almost invariably due to the action of bacteria, and in the larger proportion of fatal cases the symptoms are those of poisoning by these bacteria or their products, and not of inflammation.

These bacteria may be of different kinds, and may effect an entrance to the peritoneum by different routes, but all cases of peritonitis may be conveniently classified under one of the four following heads: (1) Peritonitis due to infection from the intestine; (2) Peritonitis due to infection from without; (3) Peritonitis of doubtful origin; and (4) Peritonitis due to infection by the tubercle bacillus, a form of the disease which presents peculiar features and will have to be considered separately.

1. **Peritonitis due to infection from the intestine.**—This would appear to be the most frequent cause of peritonitis, the infecting organism being the bacillus coli communis, which exists normally in the intestinal canal, and is perfectly harmless in the healthy intestine;

but if the bowel becomes altered in any way from the normal condition of health, the bacillus becomes virulent and shows an active inclination to penetrate the bowel wall. It may escape either through a perforation or through the wall of a portion of the gut which has been damaged by injury or disease. Examples of peritonitis set up in this way are strangulated hernia, or other forms of intestinal obstruction, appendicitis, enteritis, ulceration, with or without perforation, and cancerous growths.

2. **Peritonitis due to infection from without.**—The micro-organisms associated with this form are usually the pyogenic cocci, and notably the streptococcus pyogenes. They effect an entrance through a wound in the abdominal parietes, the result either of operation or injury; through the genital organs in the female, travelling from the vagina up the Fallopian tube; or in puerperal peritonitis reaching the peritoneum through the veins, lymphatics, or Fallopian tubes.

3. **Peritonitis of doubtful origin.**—Peritonitis is said to be caused by chemical or local irritants, and to occur in the rheumatic, syphilitic, and alcoholic conditions, or in victims of Bright's disease. If this is so, it must be admitted that peritonitis can be produced without the infection of micro-organisms, but it would appear to be doubtful whether this is really so; at all events it may be said that the existence of such a condition has not been satisfactorily proved, and that where peritonitis has been set up in this class of cases there has been, in all probability, the introduction of micro-organisms either from the outside or through the intestine.

Symptoms of acute diffuse peritonitis.—The symptoms vary within certain limits according to the cause of the affection. The patient is seized with acute pain of a burning, cutting, or stabbing character, which is generally at first localised to the seat of injury or referred to the umbilicus, but soon spreads all over the abdomen. This often presents exacerbations, the patient suddenly crying out from an access of pain. Speedy collapse follows, and he becomes faint, pale and prostrated. He lies on his back, with his thighs flexed on the abdomen. He is restless, and his features are pinched and expressive of anxiety. Vomiting usually sets in early and is persistent, whether anything is taken by the mouth or not. He rejects first the contents of the stomach, then the ejected matter becomes bilious, and finally brown and offensive. There are often eructations and hiccough. The abdominal muscles are rigidly contracted and the abdominal wall at first is sunken in, but later on the abdomen may become distended and tympanitic. The abdominal wall is hypersensitive, and the patient will often flinch from the slightest touch; there is also pain on deep pressure being made. The respiration is thoracic. The urine is scanty and loaded, and constipation is usually marked, but in some cases there is diarrhœa. The temperature presents no regular course; in some cases it rises steadily, in others it remains slightly above normal, and in others, especially cases of peritonitis from perforation, it is subnormal. The pulse is quick, small, and wiery. The tongue is dry, brown, and furred in the centre. Often intense thirst is complained of. There is rarely any delirium or impairment of the mental faculties. In fatal cases, as life ebbs away, the temperature, if it has been raised, falls abruptly, the skin becomes cold and clammy, the pain ceases, the countenance ashen and livid, and the pulse too quick to be counted. Battle points out that in these cases there is sometimes œdema, with tenderness in the groins extending to the scrotum, but not down the thighs. This may prove a diagnostic point of some value in obscure cases.

Treatment.—The treatment of acute peritonitis must be considered under two heads: (1) as regards the conduct of a case independent of operative interference, and (2) as regards operative measures.

And first it must be mentioned, that in quite the incipient stage of peritonitis the attack may be warded off by the administration of a brisk saline purge. The peritoneum is possessed of great sensitiveness, and the onset of an attack of peritonitis is attended with an impression on the nervous system, which among other phenomena produces an arrest in the peristaltic action of the bowel, and a retention and consequent decomposition of its contents, which much favours the activity of the bacillus communis coli. If a brisk purge is given, this material is got rid of, the activity of the bacillus is lessened, and the trouble may pass off; but when once the peritonitis is set up, this treatment can be of no avail.

The medical treatment of peritonitis consists in rest, abstinence from food, the administration of opium, with perhaps calomel; local bleeding, and hot fomentations to the abdomen. The patient should be kept on his back, with the shoulders slightly raised, and a pillow under his knees to relax the abdominal wall. No food should be taken by the mouth, but the patient should be fed with nutrient enemata. The thirst is best quenched by small quantities of hot water, or weak hot tea, to which a few drops of lemon juice may be added. Opium must be given to relieve pain, but no more of this drug should be administered than is required for this purpose. Formerly calomel was given in large doses in combination with opium to act as an absorbent of the effused lymph, but this plan of treatment has now fallen into disuse. In the early stages of peritonitis, in the robust, the application of half a dozen or a dozen leeches to the abdominal wall is often attended with marked benefit.

Operative measures.—It must be borne in mind that the above-mentioned measures are inoperative as far as regards getting rid of the infective poison contained in the peritoneal cavity, and that this can only be done by opening the abdomen and evacuating the fluid, and it may be washing out the cavity. Unfortunately this measure is not attended with any large amount of success, because the poison has already wrought the mischief, and the operation is resorted to too late to prevent it. Nevertheless, seeing that the disease is almost certain to prove fatal unless some such measure as this is taken, it is right in these cases to resort to operation, by which a certain small percentage of cases may be saved.

Unless there is any clear indication to the contrary, the incision is best made in the middle line, below the umbilicus. When the abdomen is opened, the effusion must be allowed to escape and then the coils of gut gently separated from each other, so as to open up any pockets of serum or pus. The different parts of the abdomen should be carefully swabbed out with sponges so as to remove as far as possible flakes of lymph, and then freely irrigated with a hot sterilised salt solution (ʒi to Oj) at a temperature of 100° F. to 105° F. After the irrigation, all superfluous fluid should be removed by sponges. The more thorough this proceeding is, the greater the chance for the patient; unfortunately in the majority of cases the patient is in such a bad condition that he will not stand any very protracted proceeding. The fluid having been removed, the surface of the peritoneum may be dusted with iodoform, a drain inserted, and the rest of the wound closed. The best mode of draining is by strips of gauze. These are placed among the intestines in different directions, and the ends are brought out through the wound in the abdominal wall. Another efficient form of drainage consists in introducing a glass tube to the most dependent part of the peritoneal cavity, and allowing the end to protrude through the external wound. At intervals any fluid which gravitates to the bottom of the abdominal cavity can be removed through this tube by an exhausting syringe, to the nozzle of which a piece of india-rubber tubing is attached. This is passed down the glass tube, and by this means the fluid can be sucked up.

McCosh strongly recommends the intra-intestinal injection of a solution of sulphate of magnesia in these cases. He believes that the safety of these patients depends upon the restoration of the peristaltic action of the intestines, and by this means diminishing the emigration of the bacillus communis coli through the walls of the intestine. It is useless to give the magnesia by the mouth because it is at once vomited, and when injected into the rectum it has not the desired effect. He therefore injects it into the small intestine, as high up as possible, by means of an aspirating needle and syringe. From one to two ounces of the salt dissolved in water at the temperature of the blood is injected. The needle puncture is closed with a Lembert's suture.

Acute localised peritonitis.—This condition occurs where there has been some localised lesion of the abdominal contents. Inflammation is set up in the peritoneum around this lesion, but does not spread to the whole peritoneal surface. At the margins of this inflamed area lymph is effused, which glues together the structures and thus acts as a barrier to the general diffusion of any inflammatory products which may be present. These products therefore remain limited, and form a circumscribed abscess in the peritoneal cavity, shut off from the greater part of the sac. Some cases of acute appendicitis are good examples of this : the inflammation in the appendix involves the peritoneum covering it, and spreads to the surrounding serous membrane to a limited extent ; it then becomes arrested, the barrier is set up and the subsequent changes in the inflammatory exudation take place in a circumscribed cavity. The pus, if it forms—for this is not always the case—may either subsequently burst through the barrier into the general cavity, and thus set up a diffuse peritonitis ; or it may burst into one of the hollow viscera ; or it may reach the surface and burst externally.

Symptoms.—The symptoms usually commence with pain, which at first may not be well defined, but after a time becomes localised and referred to the affected part ; it is accompanied by superficial tenderness, and is attended by distinct symptoms of a febrile type. The temperature is raised, the skin hot, and the tongue furred, and there is vomiting and constipation. Over the tender area there is a feeling of distinct resistance, but at first there is no swelling. Later on an ill-defined tumour may be detected, which is sometimes dull on percussion, sometimes tympanitic. The symptoms of fever increase and a rigor may occur. Subsequently signs of acute diffuse peritonitis may be set up, if the pus finds its way into the peritoneal cavity ; or the swelling may disappear suddenly, and the fever subside in some rare cases when the abscess bursts into one of the hollow viscera, and there is then a discharge of pus from the bowel, the bladder, &c., as the case may be. Most frequently, however, the abscess travels towards the surface. The skin becomes reddened, œdematous, and fluctuation can be perceived. The pus which is contained in these abscesses is usually extremely offensive and has a fæcal odour. If opened antiseptically they frequently heal up from the bottom, unless they should chance to communicate with the intestine, when a fæcal fistula will form.

Treatment.—The treatment in the early stage consists in perfect rest; the application of belladonna and glycerine to the inflamed part, followed by a hot fomentation; the administration of an enema to empty the lower bowel, and keeping the patient on a fluid diet. Sometimes the application of half a dozen leeches is followed by a speedy subsidence of the pain and a relief to the other symptoms. Should there be evidence of suppuration, or should the symptoms persist and the temperature keep up, an incision by the most direct route should be made, any pus which is found should be evacuated, and the abscess cavity drained. No serious attempt at this time should be made to deal with the original lesion which caused the inflammation, since the efforts to do so might break down the barrier of lymph, and cause general contamination of the peritoneal cavity. It is better in most instances to wait until the abscess has been thoroughly drained before doing so. Moreover, in a considerable percentage of cases the abscess will heal up without any further trouble.

Chronic peritonitis, except it is of the tuberculous variety, rarely requires the aid of the surgeon, and the subject may be dismissed in a few words. It may involve the peritoneum generally, or may be localised to a limited area. It may be the sequel of an acute attack; it may be associated with ascites, especially after repeated tapping; it may arise from morbid growths of the peritoneum, or it may occur in some cases of appendicitis or pelvic peritonitis. The **pathological changes** are subject to considerable variety. It may be attended with thickening of the serous membrane, or the formation of adhesions between the viscera and the walls of the cavity, or of one viscus with another; or in many cases effusion of some kind is present; this may be serum, or serum containing shreds of flocculent lymph, or sero-purulent fluid or pus.

The **symptoms** present much diversity. There is usually pain, or a sensation of dragging, tightness, or fullness, and this is increased by movement. There is often more or less tenderness on pressure. Constipation is frequently present, and may be very obstinate. The appetite may be impaired, and dyspeptic symptoms are complained of, especially colicky pains after food. General symptoms of slight febrile disturbance exist in most cases. If effusion is present, there will be evidence of fluid in the peritoneal cavity. Chronic peritonitis rarely calls for treatment on the part of the surgeon, though in cases where there is persistent pain and dragging in one spot, with other evidence of chronic peritonitis, it may be justifiable to open the abdomen with the view of dividing adhesions.

Tuberculous peritonitis.—Tuberculous peritonitis may occur at any age, but is most common in children after the first year of life, that is to say, after weaning. It may occur as a primary affection, but is more often secondary to tubercle elsewhere, either caseating mesenteric glands or tuberculous ulceration of the intestine; or in some cases it may spread through the diaphragm from the pleura, or the source of infection may be some tuberculous condition of the female generative organs. Several forms of the disease may occur. In acute cases the peritoneum becomes studded all over with miliary deposits, and it forms part of a condition of acute miliary tuberculosis, and rapidly proves fatal. Independent of this, tuberculous peritonitis in its chronic form presents three varieties.

1. The **ascitic form.**—In which the peritoneum becomes studded with tubercles, which have a tendency to become confluent, and considerable effusion of a clear, yellowish fluid takes place, which may occasionally become sero-purulent when the infection has been a mixed one. There are usually few, if any, adhesions in this form, which is the most amenable to surgical treatment.

2. The **fibrous form.**—This form is essentially chronic, and is characterised by the tendency to form fibrous or cicatricial tissue, which mats the viscera together. The effusion of fluid is generally very little.

3. The **ulcerative form.**—This is the most serious and fatal form of the disease. The tuberculous nodules have a tendency to caseate and soften. In these cases the contents of the abdomen become converted into a more or less shapeless mass, buried in caseous material and glued together and to the abdominal wall. The softened material sometimes finds its way through the abdominal wall, frequently at the umbilicus, and a fæcal fistula may be formed in this situation. These cases are quite unsuited for operation.

Symptoms.—The symptoms of this disease are very variable. Except in the acute miliary form, they begin obscurely. The child complains of pains about the belly, and there is usually a slight elevation of the temperature in the evening, and with this a gradual wasting and marked deterioration in health. The bowels are commonly relaxed, or there may be alternations of diarrhœa and constipation. In the ascitic form the abdomen enlarges, and is resonant in front and dull in the flanks when the child is lying on its back, and the line of dullness varies with the position of the patient. In the fibrous form the abdomen feels nodular, and there is no sign of fluid. In these cases there is less evidence of impairment of health than in the other forms. In the ulcerous form, large hard masses may be felt in the abdomen, which may be mistaken for malignant growths, and there are alternating regions of dullness and resonance. In this variety of the disease the general symptoms are much more marked than in the others. There is usually a marked exacerbation of fever towards evening, followed by sweating, vomiting, and rapid emaciation, and the case usually terminates fatally.

Treatment.—The treatment of tuberculous peritonitis in the first instance naturally falls under the care of the physician, and it is only in those cases which have resisted medical treatment that the surgeon is called in to perform laparotomy. The cases which yield the best results after this operation are those of the ascitic form, though it has also proved useful in cases of the fibrous variety, where there is also effusion. It should not be done in the acute miliary or ulcerous form of the disease, or where the peritonitis is only one part of a general tuberculosis. The operation simply consists in making an incision into the peritoneal cavity in the middle line. If the fluid is simply serous, it is evacuated, and the incision is then sewn up again without flushing and without drainage. If, however, the fluid is purulent, adhesions must as far as possible be broken down to give exit to any pus which may be localised, and the abdominal cavity flushed with a 0·6 per cent. solution of common salt or a saturated solution of boric acid. It is advisable also to insert a drainage tube for two or three days, closing the rest of the wound.

The operation, especially in cases in which the fluid is not purulent, is attended by a large measure of success, though cases of relapse, possibly due to fresh infection, not infrequently occur. We are ignorant of the mode in which laparotomy cures in these cases; it has been attributed to the relief of tension, to the admission of air or light, and to the removal of the exudation and its toxines and ptomaines. It has been abundantly proved that the removal of the fluid by aspiration is not sufficient, but that an actual incision is required.

AFFECTIONS OF THE STOMACH

Foreign bodies in the stomach.—Foreign bodies which have been swallowed are occasionally retained in the stomach and do not pass onwards. These are for the most part irregular bodies, such as plates of false teeth, or long narrow bodies, such as pencils or nails, which have been accidentally swallowed. But concretions formed of masses of hair, wool, or husks, are occasionally found in this viscus. These materials have been swallowed, at intervals, for a long period of time, and have become rolled into a ball or mass by the action of the muscular coat of the organ. The symptoms to which they give rise are pain in the epigastrium, with perhaps tenderness over the stomach; symptoms of dyspepsia, with occasional hæmatemesis. Unless a definite history can be obtained of the patient having swallowed a foreign body, the symptoms are very obscure. Occasionally a diagnosis can be arrived at by the Röntgen rays.

Treatment.—When the foreign body has remained in the stomach for some time, and it is evident that it will not pass through the pylorus, gastrotomy should be performed and the foreign body removed.

Gastrotomy.—The operation of gastrotomy is performed for removal of foreign bodies, the opening in the stomach being immediately closed. The external incision may be made in the median line, over the foreign body, if it can be felt, or by the incision for gastrostomy (see page 725). When the abdomen is opened the foreign body is felt for through the coats of the stomach, the part where it is located is pulled up to the surface of the wound, packed round with sponges, and opened with scissors in the long axis of the stomach. The opening must vary in size according to the dimensions of the body to be removed, but should always be free enough to allow of its extraction without bruising the edges of the wound. The foreign body is seized between the finger and thumb or with a pair of forceps and extracted with all gentleness. The wound in the stomach is to be closed by the Czerny-Lembert suture, all traces of blood clot &c. removed, and the external wound closed and dressed. In those cases where the foreign body is lodged in the lower end of the œsophagus or at its cardiac orifice, it may be necessary to enlarge the wound in the stomach so as to admit of the introduction of the whole hand.

Perforation of the stomach.—Ulceration of the stomach is a disease of constant occurrence, especially in young females, and more particularly in domestic servants. In these cases perforation sometimes takes place, and the contents of the stomach escape into the peritoneal cavity. The surgeon under these circumstances may be called in to repair the damage. Until within the last six or seven years these cases were regarded as almost uniformly fatal from septic peritonitis, but it is now found that if an abdominal section is performed and the perforation closed, provided the operation is done before general peritonitis is established, that is to say, within about twelve hours of the perforation, a considerable number of these cases may be saved.

Symptoms.—The symptoms of perforation are the sudden occurrence of a severe pain in the region of the stomach, often after the ingestion of a hearty meal, in a patient who has been suffering from symptoms of dyspepsia—discomfort and pain after food, vomiting or regurgitation, pyrosis and perhaps hæmatemesis. The attack of pain is followed by collapse, and the pain which was at first localised in the left hypochondrium becomes diffused all over the belly. The patient often vomits, and the vomited matter may occasionally contain blood. Upon examination there is tenderness on palpation, especially over the region of the stomach ; the breathing is generally thoracic ; the abdomen is often distended and tympanic, owing to the presence of free gas in the peritoneal cavity, and the normal liver dullness is replaced by a clear bell note.

When these symptoms are present, a perforation of the stomach may be definitely diagnosed. The perforation takes place usually on the anterior surface of the stomach, and more often towards the pyloric extremity. When the perforation takes place on the posterior surface of the stomach, the lesser bag of the peritoneum has generally become previously obliterated by adhesions, and the extravasation of food takes place outside the peritoneum and an abscess forms in the retro-peritoneal tissue. The matter travels up between the liver and the diaphragm, and usually points in the neighbourhood of the ensiform cartilage. In these cases the left pleura often becomes involved, and a collection of pus takes place in the pleural cavity. These cases of perforation of the posterior wall of the stomach do not give rise to the symptoms detailed above as occurring when the anterior wall is perforated. They are merely those of acute abscess.

Treatment.—If a diagnosis has been made of perforation of the stomach, operative interference should at once be proceeded with as the only chance of saving the patient's life. There should be no delay, as statistics have abundantly proved that it is only by operating early that a successful issue can be fairly hoped for. While preparations are being made for the operation, the patient should be kept quiet on his back, and nothing should be given by the mouth. A hypodermic injection of morphia may be given to allay pain and keep the patient quiet, and if there is severe collapse an enema of hot brandy and water.

The abdomen is to be opened by a median incision above the umbilicus, and if more room is required a transverse cut may be made through one or other rectus muscle. When the peritoneum is reached, a small puncture should be first made so as to allow the contained gas to escape slowly ; and when this has taken place, the peritoneum is divided to the extent of the external wound with scissors. Fluid and particles of partially digested food will escape. The perforation is now to be sought for, and when found drawn up to the surface of the wound, and the stomach emptied into a dressing tray or large sponge by gentle pressure. The abdominal cavity is now to be cleared of all extraneous matter by careful sponging in a systematic manner, commencing at the top of the abdomen and gradually working the way down into the pelvis, so that all particles of food which have escaped from the stomach may be dislodged from the folds of the peritoneum. The next step in the operation consists in closing the perforation. This can be done by turning in a tuck of the wall of the stomach and sewing the margins of the tuck together. The viscus is held by an assistant rather loosely on either side of the ulcer, and the surgeon with his forefinger pushes the ulcer inwards, so as to invaginate it into the stomach, and then sutures the two folds together, taking care that his needle passes into the sub-mucous tissue, but does not perforate the mucous membrane. It is not necessary to excise the ulcer and bring the raw edges together. This materially prolongs the operation, and is often attended with considerable loss of blood. If the surgeon is not confident that his opening is quite closed and water-tight, he may cover the line of suture with an omental graft or insert a second row of stitches. Before closing the external wound, it is a good plan to flush out the cavity with hot sterilised water, or a normal saline solution at a temperature of 100° to 105° F. If this is done, care must be taken to mop out all the fluid afterwards with a clean sponge. A drainage tube must be inserted, which may be either of gauze or a glass tube (see page 811), and the rest of the wound closed and dressed. The patient should be fed by nutrient enemata for the first forty-eight hours.

In those cases where it is impossible to close the perforation by sutures, one of three courses may be adopted: (1) The most efficient plan is to close the perforation by suturing a piece of omentum over it. (2) A tube may be passed into the stomach, and the abdominal wall closed around the tube, with strips of gauze packed all round. (3) The margins of the perforation may be stitched to the abdominal incision, and a gastric fistula formed. This is a less satisfactory plan than either of the other two.

When the perforation is on the posterior surface of the stomach, its existence can usually be ascertained by passing the finger through the foramen of Winslow. In order to expose and suture it, the surgeon must either carefully tear through the lesser omentum, and by inverting the anterior wall bring the posterior surface into view through the hole thus made; or else tear through the great omentum between the greater curvature of the stomach and the transverse colon.

Stenosis of the stomach.—When the mucous membrane of the stomach has been destroyed either by injury or disease, after healing has taken place, the scar tissue contracts and produces stenosis. This condition may arise either after the healing of simple ulcers, or when the mucous membrane has been destroyed by swallowing caustic fluid, or after blows or other injuries of the stomach. The contraction may be at any part: at the pylorus, giving rise to simple cicatricial stricture of the pylorus; in the fundus, when the contraction may be so great as almost to divide the organ into two parts, with a narrow channel of communication between, so that the stomach assumes the shape of an hour-glass (fig. 315); or the contraction may be at the cardiac orifice, generally when the disease is due to swallowing caustic fluids.

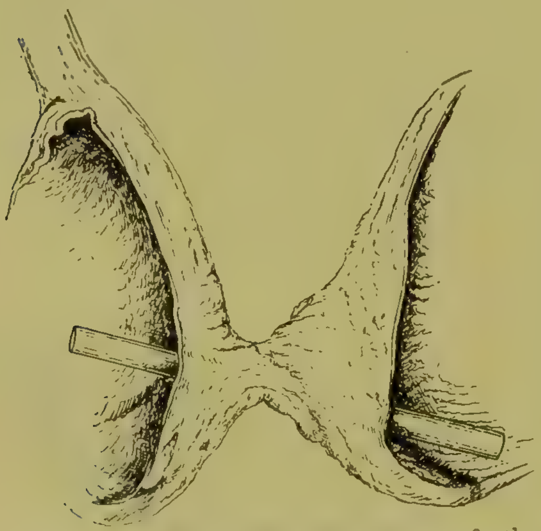
FIG. 315.—Hour-glass contraction of the stomach. (From the Museum of St. George's Hospital.)

The **symptoms** are pain in the hypochondriac region, with a feeling of distension and flatulence and frequent vomiting. The patient does not as a rule vomit the whole of the food taken, but is generally sick some hours after each meal, bringing up a quantity of sour fermented fluid; but the vomited matter rarely contains blood. There is gradual wasting and loss of strength. Upon examination it will be found in those cases where the stricture is at the pylorus that the stomach is very considerably dilated, whereas in cases of hour-glass contraction the dilatation is not so great, and what dilatation there is is not uniform, and is situated at the cardiac end. In addition to this, in these latter cases, upon listening with a stethoscope a gurgling sound may be heard, as of fluid running through a narrow orifice about the centre of the stomach.

Treatment.—The surgical treatment of stenosis differs somewhat as to whether the contraction is at the pylorus or in the centre of the stomach. When it is situated at the pylorus, the old plan of treatment was by Loreta's operation, which consisted in opening the stomach near the pylorus and inserting one or two fingers through the pyloric opening and forcibly stretching it. This treatment was frequently followed by relapses, and has now been superseded by pyloro-plasty. Loreta recommends the same treatment for stricture at the cardiac orifice; but in consequence of the depth of this part, and the difficulty in introducing the finger, he has devised a special dilator for these cases.

Pyloro-plasty.—In this operation the stomach is exposed and an incision is made in the long axis of the gastro-duodenal canal over the pylorus, so that it extends one inch on either side of the valve into the stomach wall and duodenum respectively. This incision divides all the coats, and therefore necessarily the stricture (fig. 316, A). The edges of the wound are then seized with forceps on either side near their centre and stretched transversely, so as to convert it into a diamond-shaped cut, and the margins are united transversely to the long axis of the bowel (fig. 316, B).

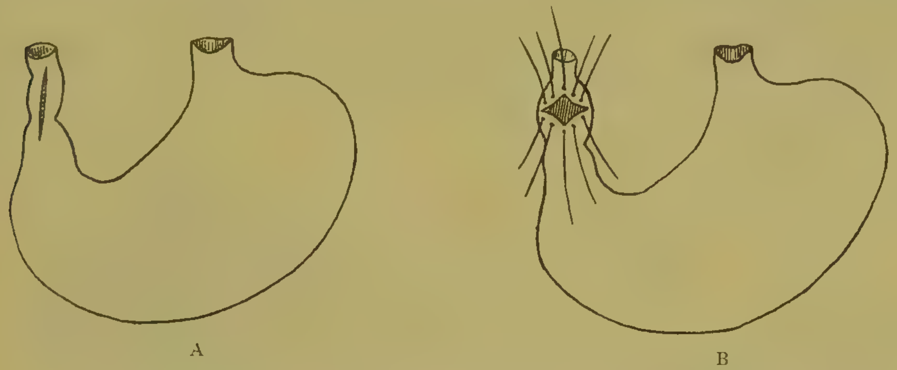

FIG. 316.—Pyloro-plasty. A, the longitudinal incision; B, the diamond-shaped wound and the manner of inserting the sutures.

Another plan of treating fibrous stricture of the pylorus is by gastro-enterostomy, or making an artificial opening between the stomach and intestine. This operation is easier in its performance and is quite as efficacious. It will be described in connection with cancer of the pylorus.

For the treatment of hour-glass contraction two operations are available. (1) A very similar operation to pyloro-plasty may be performed (gastro-plasty). This consists in making a transverse cut through the stricture; that is to say, a cut at right angles to it, dividing all the coats of the stomach for about an inch on either side, and then suturing the cut edges in a vertical direction, so that the horizontal wound is converted into a vertical one after suturing. (2) A gastro-anastomosis may be done. An incision is made through the coats of the stomach, in the dilated portion on either side of the stricture, and the two openings are then united together by a Murphy's button, a Senn's plate, or by simple suturing (fig. 317).

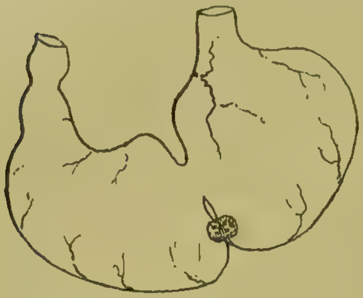

FIG. 317. – Gastro-anastomosis by means of Murphy's button.

Congenital hypertropic stenosis of the pylorus.—Another form of stricture of the pylorus occurs in infants; the symptoms showing themselves for the most part within a few days after birth, but almost invariably within the first month. The disease consists in an hypertrophy of the circular muscular coat, with secondary changes in the other coats. No explanation has been given of the cause of this condition.

The **symptoms** consist in persistent vomiting, the vomited matter being free from bile; obstinate constipation, and the presence of a tumour in the region of the pylorus. These symptoms occurring in a child during the first month of life, with an absence of signs of gastritis or intestinal obstruction, would lead to the diagnosis.

Treatment has hitherto been merely palliative, but pyloro-plasty appears to be indicated in these cases.

Cancer of the stomach.—Cancer of the stomach is a common disease of somewhat advanced life, and occurs more frequently in the male than in the female. The disease most frequently attacks the pylorus (fig. 318), but may occur at any part of the stomach; it belongs to the form of cylindrical epithelioma, and speedily ulcerates and extends to neighbouring parts, so that, in the generality of cases, the growth has spread and become fixed before the symptoms are sufficiently pronounced to make

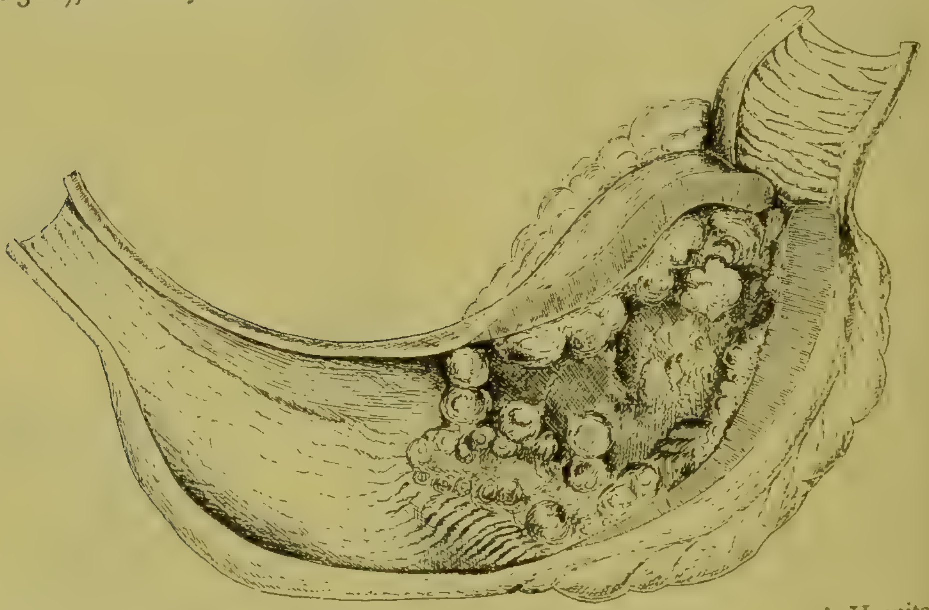

FIG. 318.—Carcinoma of the pylorus. (From the Museum of St. George's Hospital.)

a diagnosis. This is especially the case when the disease affects the pylorus.

Symptoms.—The disease commences with ordinary symptoms of dyspepsia—pain and discomfort after taking food. This is followed by vomiting and rejection of a portion of the food after it has been in the stomach some time. Accompanying this is severe pain in the right hypochondrium and in the back, between the scapulæ. The patient wastes rapidly, and after ulceration has taken place hæmatemesis sets in, and blood is sometimes brought up in large quantities. When the pylorus is affected the stomach becomes dilated, sometimes enormously, and a hard fixed mass can after a time be detected in the situation of the pylorus. When the cancer is in other parts of the stomach, a hard, somewhat irregular tumour can usually be felt in the situation of the disease; this is more movable than when the growth is situated at the pylorus.

Treatment.—The surgical treatment of pyloric cancer consists mainly in performing one of two operations: (1) resection of the pylorus; or (2) gastro-enterostomy. Other operations have been recommended; (3) curetting, which consists in removing with a sharp spoon as much of the cancerous growth as is possible through an opening made in the stomach; and (4) duodenostomy or jejunostomy, making a fistulous opening into the small intestine, through which the patient is fed. These two latter operations are not to be recommended.

In selecting one of the two operations, resection of the pylorus and gastro-enterostomy, the surgeon must be guided by the condition of parts when the abdomen is opened. When the tumour is freely movable and the neighbouring parts are not implicated, resection is to be recommended, as the more curative proceeding of the two. But in the majority of cases, before operative proceedings are undertaken, the tumour has become so fixed and has so far implicated surrounding parts as to render removal impossible; under these circumstances gastro-enterostomy, or making an artificial communication between the stomach and intestine, must be undertaken. The operation of resection is therefore rarely performed, and it would appear that in most cases in which it has been done, recurrence has taken place very rapidly; moreover, it is an operation of great severity, and is attended by a very large mortality.

Resection of the pylorus (*pylorectomy*).—There are two methods of performing this operation—by direct suture, and by the use of some appliance, as Murphy's button or Senn's plate. Since the introduction of this latter method the results obtained have been more favourable, as the time taken in performing the operation is very materially curtailed. The stomach should be thoroughly washed out before the operation, and the abdomen having been opened, the growth is thoroughly isolated from the omenta and surrounding structures and brought up to the surface of the wound. The stomach and duodenum are clamped well beyond the disease on either side, and the parts are carefully packed round with a ring of sponges to prevent any of the contents of the stomach or intestine getting into the peritoneal cavity. An incision is then made from the lesser curvature downwards towards the greater curvature so as to extend about halfway across the organ, well on the proximal side of the disease (fig. 319, A). The opening thus made in the stomach is now closed by a series of Czerny-Lembert sutures (fig. 319, B). The third step in the operation consists in completing the section of the stomach, and dividing the duodenum well on the distal side of the growth and removing the tumour.

The two divided surfaces are now brought together and sutured by Czerny's suture (fig. 319, c), and finally the serous membrane is brought together over them by a ring of Lembert's suture, so that the line of union is sequestrated.

The more recent method of performing pylorectomy is by the use of Senn's plate or Murphy's button. The operation consists in exposing the stomach and freeing the growth from surrounding parts. Clamps having been applied to the stomach and duodenum, the mass is cut away by a section through the stomach and duodenum in healthy parts clear of the disease. The opening in the stomach is now partially closed by a Czerny-Lembert suture, commencing at the lesser curvature and stopping at about an inch from the greater curvature, leaving an opening sufficiently large to admit of the introduction of the Senn's plate or Murphy's button. If the latter is to be used, a purse-string ligature is now applied around this opening, and the female half of the button having been introduced, the ligature is tied tightly around the central tube. A similar ligature is now run round the open end of the duodenum, and the male half of the button introduced into this tube and the ligature tied. The two halves are pressed together and united, and the anastomosis is completed. The toilet of the peritoneum is now to be proceeded with, and the external wound closed. It will probably be desirable in these cases to insert a drain for twenty-four or forty-eight hours.

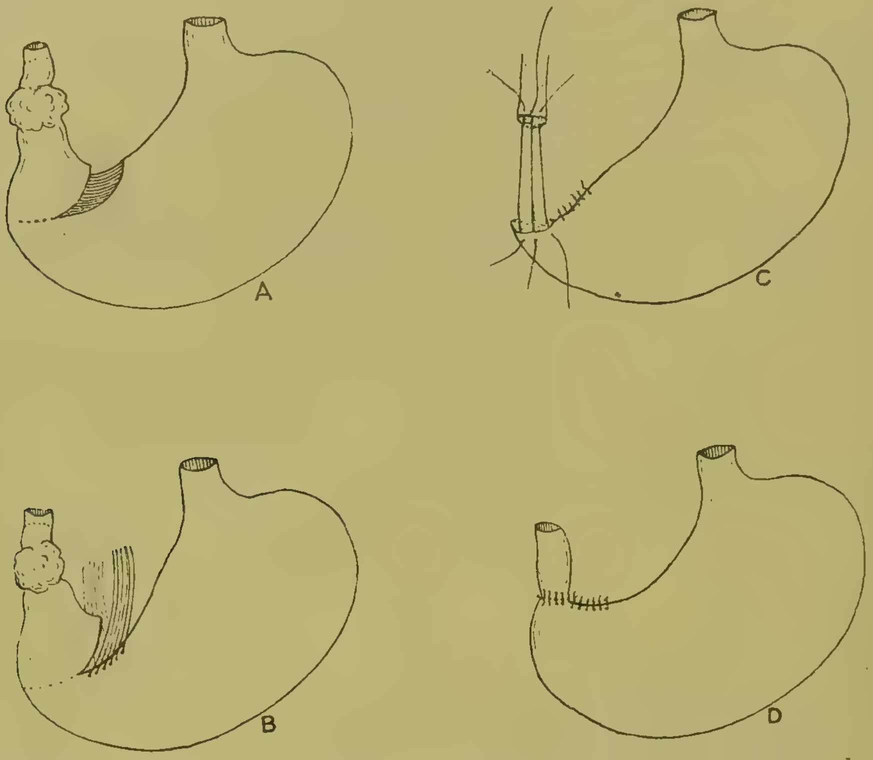

FIG. 319.—Pylorectomy. A, first incision; B, insertion of sutures to close opening in stomach; C, junction of duodenum to stomach; D, completed operation.

Gastro-enterostomy consists in making an opening between the stomach and the small intestine as high up as possible, so that the contents of the stomach may find their way into the bowel, without having to pass over the diseased and contracted structures at the pylorus. The operation is, of course, entirely palliative, but it affords the patient great relief, and no doubt prolongs life by saving the patient from the horrors of slow starvation. In performing the operation, care must be taken to open the intestine as high up as possible, the duodeno-jejunal junction being the point which should be selected. Cases have been recorded where the lower part of the ileum has been opened by mistake and the patients have died of inanition. The commencement of the jejunum can be found with ease by drawing the omentum and transverse colon upwards and to the right, when this portion of the bowel will be seen lying along the under border of the pancreas close to the bodies of the vertebræ. The posterior wall of the stomach should be utilised for making the anastomosis; this is easily reached by tearing a hole in the transverse meso-colon and forming the junction through the rent. If the anastomosis is made on the anterior wall, the loop of small intestine has to be dragged up over the transverse colon, and this causes a strain on the loop, which prevents the perfect emptying of the stomach, and moreover tends to direct the contents of the duodenum into the stomach rather than in the opposite direction. This is avoided if the junction is made on the posterior surface.

The junction may be made by (1) suturing; (2) Senn's plates; (3) Murphy's button; (4) decalcified bone bobbin. When the patient can stand the extra time required for the operation by suturing, this plan appears to give the best results.

The operation by Halstead's method is thus performed: the stomach should previous to the operation be thoroughly washed out with some mild antiseptic lotion, boric acid solution or Condy's fluid. The abdomen is incised in the middle line above the umbilicus, and the peritoneal sac opened. The duodeno-jejunal junction is first to be sought for, in the manner mentioned above, and a point selected an inch or two below it, so as to allow of the gut being easily brought up to the stomach, and the intestine is to be clamped on either side of this point. A hole is made through the transverse meso-colon by tearing so as to avoid the vessels, and the posterior surface of the stomach reached through the lesser sac of the peritoneum. The selected portion of jejunum is now brought up and laid alongside of the posterior wall of the stomach at the point at which it is intended to open it, generally about an inch from the lower margin. Half a dozen square sutures are passed in a row between the jejunum, half an inch from its mesenteric attachment, and the posterior surface of the stomach. Halstead's square suture is practically a double Lembert's suture, a loop being formed at one end and a knot tied at the other (fig. 320, A). They have the advantage that they tear out less easily and constrict the tissues less than Lembert's suture. They are passed into the submucous coat. These sutures are tied and cut off short. At either end of this row of sutures two or three more square sutures are placed, nearer the free border of the gut; these are not tied at present (fig. 320, B). Six similar sutures are now placed in a row parallel to the first series, but about three-quarters of an inch distant from them (fig. 320, C). These sutures are not tied, but are drawn aside—in the same way as in a case of abdominal section, the sutures after they have been applied are drawn away to permit of the extraction of a flat sponge which has been applied over the intestine during their insertion. Between the two rows of suture an incision is now made into the stomach, and a corresponding one into the jejunum (fig. 320, D), and all the remaining sutures rapidly tied and cut off short. The anastomosis is now complete, and Halstead states that it can be easily done in ten minutes. The opening in the meso-colon may now be brought together with one or two fine catgut or silk sutures, the peritoneum cleansed, and the external wound closed.

When in the performance of the operation time is of essential importance, anastomosis by Senn's plates or Murphy's buttons should be resorted to.

Senn's plates are exceedingly useful in performing gastro-enterostomy, and the operation, in the hands of one accustomed to their use, can be done with great rapidity, but they possess the decided disadvantage that the opening of communication after their use is liable to contract. Senn's plates are made of decalcified bone (fig. 311). The portion of the jejunum having been selected and clamped on either side, an incision about one and a half inch long is made in the long axis of the bowel, through all the coats, and the canal opened. The interior of the tube is now mopped out with pledgets of aseptic wool, and the plate introduced through the wound edgeways. It is then turned so that the surface from which the sutures

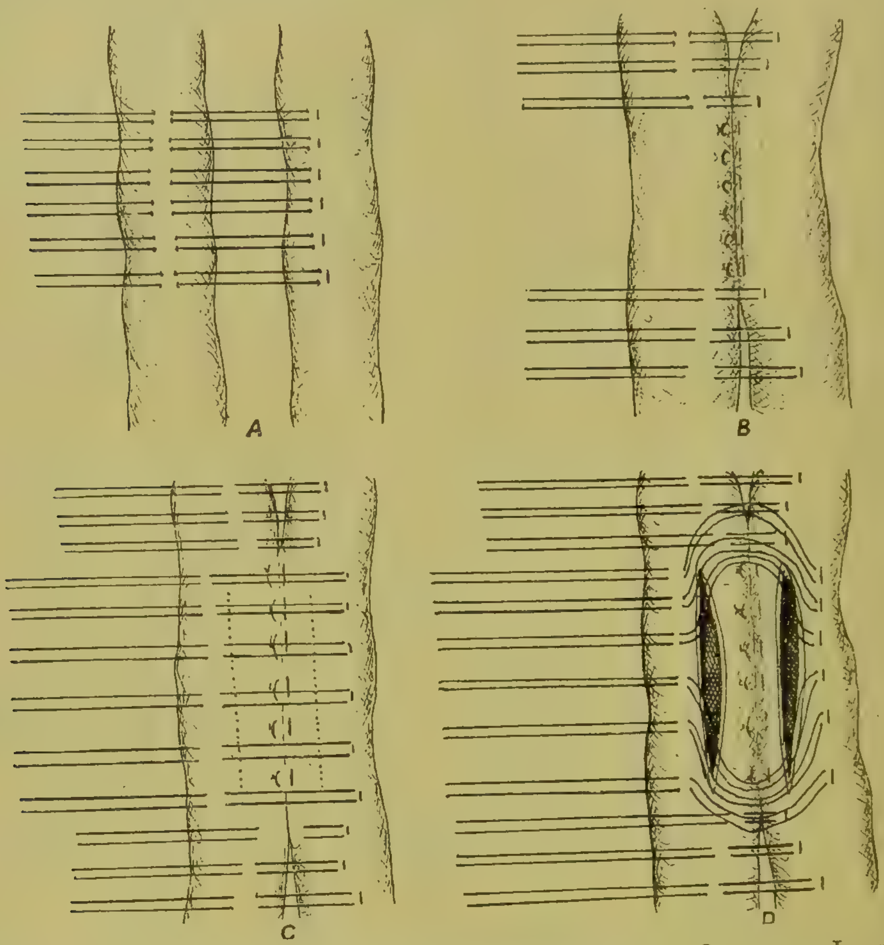

FIG. 320.—Lateral anastomosis by Halstead's method. A, first stage: Insertion of first row of sutures; B, second stage: First row of sutures tied: insertion of sutures at either end; C, third stage: Insertion of second row of sutures (the dotted line indicates where the incision is to be made); D, fourth stage: Incisions made; second row of sutures ready to be tied.

protrude faces the operator, and the hole in the plate corresponds to the wound in the gut. The two lateral sutures, which have previously been armed with a needle, are now passed through the wall of the gut by introducing the needle from the mucous surface outwards near the edges of the opening. The two end sutures are allowed to hang out of the upper and lower extremity of the wound. The stomach is now similarly dealt with, and a bone plate inserted into this viscus. The two portions of peritoneum which cover the plates and which are to be brought into contact are now slightly scratched with the point of a needle and the two plates approximated to each other, so that the holes in them exactly correspond, and the two layers of peritoneum covering the plates where they are in contact along the posterior margin are united by a few interrupted sutures. The strings are now tied; first the lateral strings farthest from the operator, then the two end strings, and finally the lateral strings nearest the operator. Two or three interrupted sutures are now inserted into the peritoneal coats along the anterior margins of the plates, sewing them together, and the anastomosis is completed.

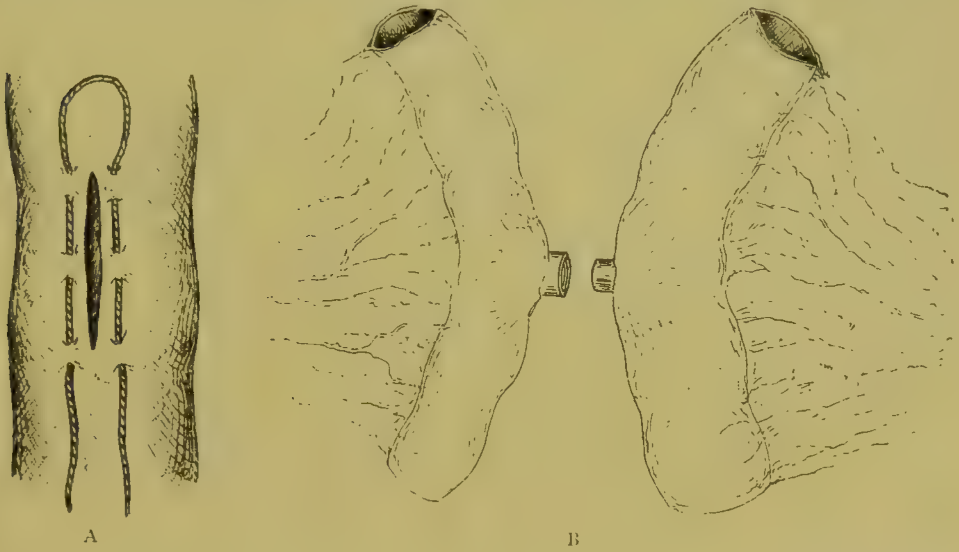

FIG. 321.—Lateral anastomosis. A, diagram showing the manner of applying the purse-string suture in using Murphy's button; B, mode of joining the two halves of the button.

Gastro-enterostomy by means of Murphy's button is the most rapid way of performing the operation, but in these cases there appears to be a particular tendency for the button to be retained in the stomach, where it may set up unpleasant symptoms and may require a subsequent gastrotomy for its removal. It is said also that contraction of the opening occasionally takes place after the use of this appliance. The button in these cases is inserted in the following manner: a running thread is first inserted into the jejunum at the point selected for the anastomosis. A needle carrying about fifteen inches of silk is inserted through all the coats of the gut, and brought out again. This stitch should be in the long axis of the gut, and about the third of the length of the future incision; the needle is again introduced in the same line and a second stitch made, and again a third; a loop is now left in the thread, and three similar stitches are inserted parallel to the first three, but in the reverse direction, so that after the final stitch the end of the silk is brought out close to the point where the first stitch was introduced. The two parallel rows of stitches should be about half an inch apart (fig. 321, A). An incision, about two-thirds the diameter of the button, is to be made into the bowel, midway between the two rows of suture, and the male half of the button introduced into the gut through this opening in such a way that the end of the central hollow cylinder protrudes; the running thread is now to be tensed and tied around the central tube. A similar proceeding is carried out on the posterior surface of the stomach, and the female half of the button introduced and secured. The two halves of the button are then approximated and closed (fig. 321, B).

When the cancer is situated in other parts of the stomach than the pylorus, it may be right to consider the feasibility of removing the whole or part of the stomach. In one case recently the whole of the stomach, including the cardiac and pyloric orifices, was removed by Dr. Carl Schlatter of Zurich with success, and eleven weeks afterwards the patient was out of bed and at work all day long, and took with few exceptions the ordinary diet of the patients.[1] She had gained in weight eleven pounds since the operation.

Gastric fistula.—An artificial communication may be made between the stomach and the surface of the body, as the result of injury, generally gunshot wounds; from cancer of the stomach, or perhaps rarely after simple ulceration. Where it is due to non-malignant cancer, an attempt should be made to close the opening. The abdomen must be opened over the site of the fistula, and the stomach separated from the abdominal wall. The cicatricial tissue around the fistulous opening in the stomach is to be cut away, and the rawed edges sutured with a Czerny-Lembert suture. The soft parts around the cutaneous opening are now excised, and the wound in the abdominal wall closed.

There are one or two other operations on the stomach which require mention. In some cases of largely dilated stomach it has been proposed to fold in a tuck of the stomach wall, and unite the edges of the tuck together, so as to diminish the size of the organ. This operation is not likely to come much into vogue, for it is difficult to understand how dilatation of the stomach can occur except as the result of pyloric stenosis; and as the adoption of this operation is treating a symptom rather than the cause of the symptom, the endeavours of the surgeon should be directed to removing the stenosis by one of the ways indicated above. Secondly, an operation is sometimes performed for freeing adhesions which have formed between the stomach and parietal peritoneum. These adhesions, the result of a former peritonitis, are often the cause of very severe pain and gastric disturbance, which may be entirely relieved by opening the abdomen and dividing them between two ligatures.

AFFECTIONS OF THE LIVER

Abscess of the liver.—Abscesses of the liver may arise from many causes, but from a surgical point of view it is only necessary to differentiate those cases where there is one abscess, or at most a couple, from multiple abscesses of the liver, as the former are only suitable for surgical treatment. The single abscess of the liver is most frequently the so-called tropical abscess; but may also arise from the suppuration of an hydatid cyst; from injury; or from the irritation caused by the presence of a gall stone in one of the intra-hepatic ducts. Multiple abscesses of the liver are in the majority of instances pyæmic. Tropical abscess of the liver occurs in those who have lived for some time in hot climates, and is in a large percentage of cases the sequel of dysentery; for a micro-organism, the *amœba coli*, which is found in the bowels in dysentery, is contained in the pus. It may, however, occur independently of dysentery in patients who are exhausted by malaria only.

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[1] *Lancet*, January 15, 1898, page 141. A further report states that the patient died one year and nearly two months after the operation, with dissemination of the growth in the mesenteric, retroperitoneal, bronchial and supra-clavicular glands, and in the pulmonary pleura. A second case of removal of the entire stomach for carcinoma has since been reported in the *Boston Medical and Surgical Journal*, May 5, 1898, by Dr. C. B. Brigham. Seven weeks after the operation the patient's condition was in every way satisfactory.

The **symptoms** are pain and a sensation of weight over the region of the liver, accompanied by a varying amount of fever. In acute cases the fever is very considerable, and is accompanied by rigors, profuse sweating, and progressive debility, and the pain is severe and extends to the right shoulder. In the sub-acute form the pyrexia is not so great, but there is usually a nightly rise in the temperature, loss of appetite, and progressive failure of strength and emaciation. There may be a slight icteric tingeing of the skin and conjunctiva, but in some cases there is no jaundice. Upon examination, enlargement of the liver can usually be made out, and there is tenderness on palpation. Frequently a distinct elastic swelling may be felt, in which there is fluctuation. The abscess may find its way to the surface, and may point below the margin of the ribs; or it may track upwards, and perforating the diaphragm burst into the pleural cavity, forming an empyema, or into the lungs, when the pus will be expectorated. More rarely it bursts into the peritoneal cavity, or into one of the hollow viscera of the abdomen, such as the duodenum or the colon. It is usually recommended that the diagnosis of abscess of the liver should be confirmed by the exploring syringe, but there is a certain amount of risk in doing this, for a leakage of pus into the peritoneal or pleural cavity may take place. Where the abscess is near the surface and fluctuation can be felt, it is not necessary; and if it is deeper and the case more doubtful, it is safer to expose the liver first before introducing the exploring needle.

Treatment.—The only safe treatment in these cases is to open the abscess and drain. It may be opened through an incision in the abdominal wall, in the thoracic wall, or in the lumbar region. The first of these three positions is best suited for the operation, when in consequence of the site of the abscess it is possible to employ it. The abdominal wall is incised over the swelling, and unless the peritoneum is adherent, sponges are packed all round the exposed liver surface. If the abscess projects from the surface of the liver, an incision may at once be made into it and the pus evacuated; but if the abscess is more deeply seated, an exploring syringe is driven into the liver in its supposed situation. When the pus is found, a thermo-cautery at a dull red heat is passed down by the side of the exploring needle until it reaches the abscess. When the cavity is opened the finger is introduced, the liver hooked forwards against the abdominal wall, and the contents allowed to escape. The surgeon while his finger is in the cavity searches for any other collections of pus in the neighbourhood, and if these are found breaks down any intervening tissue with his finger. The sac is now washed out to remove any remains of the pus or any sloughs which may be present, and the margins of the hepatic wound are united to the abdominal incision. The cavity may now either be packed with a long strip of iodoform gauze, the end of which is left protruding from the wound, or a soft large-sized drainage tube may be inserted, and the wound covered with a large antiseptic dressing.

Operation through the thoracic wall.—In many cases of abscess of the right lobe of the liver, it is impossible to open them through an abdominal incision, and it is then necessary to perform the operation by the 'transpleural' route. The patient is turned on to his left side, and an incision is made in the long axis of a rib over the most prominent part of the hepatic swelling; the rib is exposed, its periosteum separated, and about three inches excised. The pleura costalis is then divided. In some instances this will open a circumscribed empyema, or the two layers of the pleura will be found to be adherent and the pleural cavity obliterated; if this is so, the diaphragm may be at once incised; but, if not, the diaphragm is sought for at the bottom of the wound, and the pleura covering its surface divided in a line with the original incision; the serous membrane is then dissected up for a short distance on either side of the incision, and the margins united to the cut edge of the pleura costalis by a continuous suture. An incision is now made through the diaphragm, which is exposed at the bottom of the wound, and the margins of the incision dissected up for a short distance and sutured to the margins of the wound in the skin. It is now advisable to pack the parts with antiseptic gauze and delay the opening of the abscess for a couple of days, until adhesions have formed, and the pleural cavity has become entirely shut off. At the end of this time the abscess is to be opened in the manner recommended in the abdominal incision.

In some rare cases the abscess in the liver occupies the posterior portion of the right lobe, and extends downwards and backwards into the lumbar region. The abscess can then be incised in this situation without opening the peritoneum.

Sub-phrenic abscess is a localised collection of pus between the under surface of the diaphragm and the convex surface of the liver. It may arise from many causes: (1) traumatism; (2) ulceration of some part of the alimentary canal; (3) secondary to appendicitis; (4) affections of the kidney and perinephritic tissue; (5) diseases of the thoracic viscera; and (6) pyæmia.

The **symptoms** are often obscure; there is pain over the lower part of the right chest; the respiratory movements are diminished in this part, and the thoracic and abdominal walls more or less fixed; there is increased resistance on palpation of the affected area and dullness on percussion, unless gas is present in the abscess cavity, when there is increased and amphoric resonance. Above this is the ordinary lung resonance, and vesicular breath sounds are to be heard. The liver is pushed down, and can be felt below the costal margin.

When a diagnosis is made, the abscess must be opened by one of the three routes mentioned in discussing the subject of the treatment of abscess of the liver, and the details of the operation are the same.

Hydatid cysts of the liver.—Hydatid cysts are more common in the liver than in any other part of the body. The life history of this parasite has already been discussed (page 261).

The **diagnosis** of an hydatid cyst of the liver is often difficult. The presence of a slowly growing painless enlargement in the hepatic region, which moves synchronously with respiration and is connected with the liver, without fever, loss of flesh, or jaundice, suggests hydatid cyst; and if the swelling is elastic or fluctuates on palpation, the diagnosis is rendered more certain, but can only be absolutely established, when the tumour is deeply seated, by an exploratory incision to expose the liver, and then by the use of the aspirator. The fluid withdrawn is usually clear or slightly opalescent, of a low specific gravity, as a rule contains no albumen, and under the microscope reveals scolices or hooklets. The disease may give rise to little or no trouble, and the symptoms may subside spontaneously, from death of the parasite. The fluid then becomes absorbed, the wall contracts, and a shrunken cyst results, which after a time may become calcareous, and give rise to no further trouble (fig. 322).

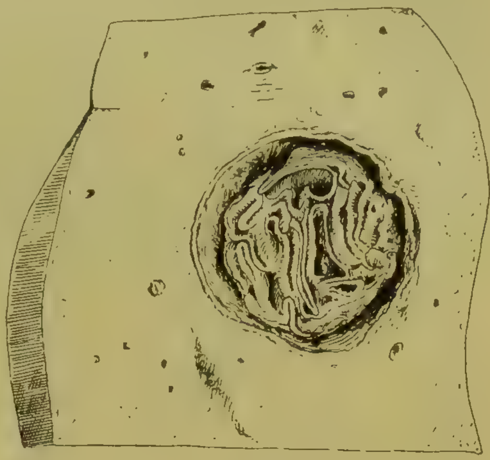

Fig. 322.—Shrivelled hydatid cyst of the liver. (From the Museum of St. George's Hospital.)

Treatment.—The only treatment suitable for these cases is incision and drainage or excision; former plans of treatment by puncture, electrolysis, or the application of caustics should be entirely discarded. The treatment by incision or excision may be carried out in two sittings, or be completed at one time. Probably in most cases, unless the tumour projects freely below the costal margins, it is wiser to perform the operation in two sittings. The operation may be performed, as in opening abscesses, by the abdominal, thoracic, or lumbar route. In the majority of cases the abdominal incision may be selected. An incision is made either in the right semilunar line or linea alba, or through the rectus muscle over the most prominent part of the tumour, and when the peritoneal cavity is opened the cyst wall will generally present. If the peritoneal cavity is not obliterated, the parietal and visceral layers are connected by a few sutures, and the remainder of the operation deferred for a couple of days. Then the hepatic tissue over the cyst, if there is any, is incised, and the adventitious cyst wall is exposed and divided. The nozzle of a syringe is now introduced between the fibrous capsule and the true wall of the cyst, and water injected. If no inflammatory changes have taken place, this will be sufficient to separate the cyst from its adventitious coat, and it may be removed entire. If this cannot be done, and the cyst is of moderate size and does not extend deeply into the liver substance, an attempt may be made to dissect out the true cyst from its adventitious coat. In either of these two cases, after the removal of the cyst, the wound in the liver substance may be united by a series of sutures, a drainage tube having been first inserted. Where the cyst cannot be removed, the contents should be evacuated, the internal aspect of the cavity scraped with a sharp spoon, and after irrigation packed with a long strip of antiseptic gauze. Daily after the operation the gauze should be removed, the cavity irrigated, and fresh packing applied.

Tumours of the liver.—Tumours of the liver have recently been subjected to surgical treatment by 'resection of the liver,' by which is meant removal of a portion of that organ. These tumours are generally malignant, either primary sarcoma or carcinoma which has commenced in the gall bladder, and has extended to the liver substance; but the operation has also been performed for innocent tumours, angioma, adenoma, hydatids, and syphilitic tumours, and in one instance for a herniated portion of liver which could not be reduced. The abdomen is opened and the diseased portion of liver exposed. In cases of malignant tumour the liver must then be carefully examined to ascertain whether there are any secondary growths, as is very frequently the case (fig. 323). When this is so, no attempt must be made to remove the growth, but the external incision must be at once closed; but when the tumour is single, and it is thought that it is possible

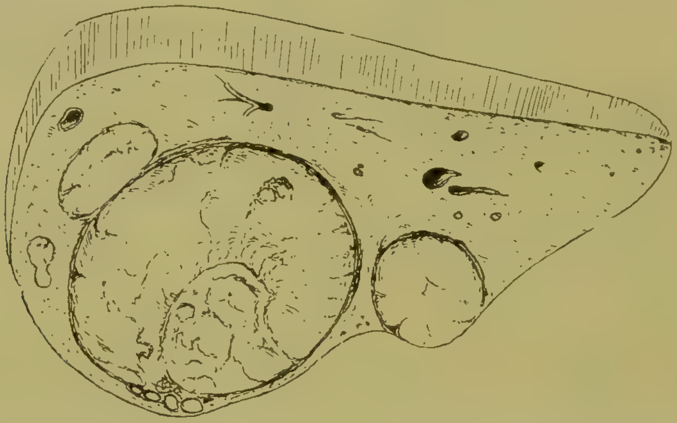

FIG. 323.—Malignant tumour of the liver, with numerous secondary growths in its substance. (From the Museum of St. George's Hospital.)

to remove the whole of the growth, the circulation is to be controlled by compressing the portal vein and hepatic artery in the lesser omentum either with the finger and thumb or a clamp. A wedge-shaped portion of liver containing the tumour is now removed; the vessels which have been divided are picked up with artery forceps and ligatured, and the cut surfaces are brought into apposition and sutured. The sutures are passed with a fully curved *blunt* needle, which is introduced about half an inch from the margin of the wound, carried to the bottom and then through the tissues on the other side. They must not be tied too tightly, or they will cut their way out. The external wound is then closed.

Affections of the gall bladder and biliary passages.—Inflammation of the gall bladder may be catarrhal, when it falls more immediately under the care of the physician, or it may be suppurative (empyema of the gall bladder), when it may call for surgical interference.

Empyema of the gall bladder is, as a rule, associated with gall stones; but typhoid and other fevers, tumours of the bile ducts, and perhaps other causes, may predispose to this condition, which is primarily set up by infection by the bacillus coli communis, which effects an entrance through the bile ducts.

The **symptoms** are swelling in the situation of the gall bladder, accompanied by constant pain and tenderness in this situation. There is increase in the temperature and rigors or chills; loss of appetite, vomiting, and constipation, which is often a marked feature, and must not be mistaken for intestinal obstruction. The swelling in the early stage can be defined as a rounded tumour which moves with respiration; later on the swelling becomes more diffused, and the movements are not so marked. After a time the gall bladder ulcerates and perforates, and a local septic peritonitis is set up, which may in some instances become general. Usually the pus makes its way to the surface, and points under the right costal margin, or at the umbilicus, following the course of the suspensory ligament of the liver, and the result is fistula.

The **treatment** consists in opening the abscess and draining, after the gall bladder has been attached to the external wound, if adhesions have not taken place. If the inflammation has arisen from the presence of gall stones, they should be removed at the same time.

Cholelithiasis is the name given to the presence of gall stones in the gall bladder. They may give rise to very few symptoms, as long as they remain quiescent (fig. 324), beyond a certain amount of dyspepsia with an ill-defined pain or sense of uneasiness in the right hypochondrium, or they may lead to dropsy of the gall bladder, due to accumulation of the natural secretion of the mucous lining. In these cases a tumour presents itself below the eighth or ninth rib. It is somewhat pyriform in shape, and its long axis is usually directed from the ninth costal cartilage downwards and inwards to the umbilicus. It is firm and elastic, and moves with respiration, and may attain a very considerable size.

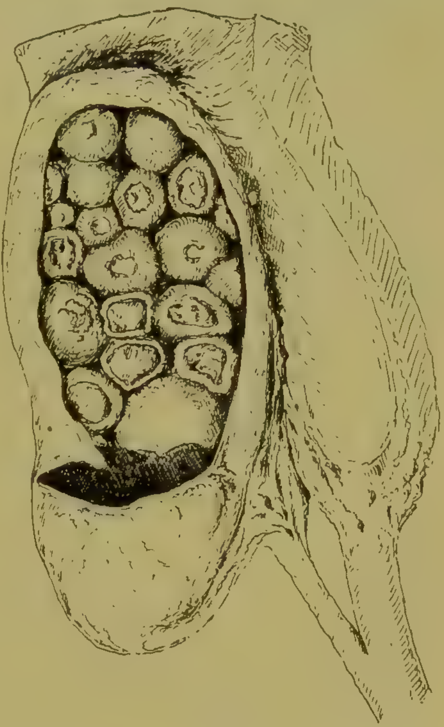

FIG. 324.—Gall bladder full of gall stones. (From the Museum of St. George's Hospital.)

When the gall stones attempt to escape by the ducts from the bladder, a very characteristic train of symptoms is set up, which is known under the name of *biliary colic*, and may come on at intervals, constituting *recurring biliary colic.* The patient is suddenly seized with the most acute pain in the right hypochondrium, radiating to the right scapular region and shoulder. It is accompanied by great prostration and exhaustion, and continues until the stone finds its way into the duodenum or falls back again into the gall bladder. In some instances in the passage onwards of a gall stone through the ducts it becomes impacted in one of these tubes; the symptoms then vary according to the position in which impaction has taken place. If the stone is impacted in the common bile duct, the symptoms are jaundice with absence of enlargement of the gall bladder; and frequent attacks of pain, during which the jaundice is intensified. The duct is seldom completely obstructed, so that there is not sufficient backward flow to produce dilatation of the gall bladder. When the stone is in the cystic duct (fig. 325), there is distension of the gall bladder with mucus (dropsy), but no jaundice. After the gall stone has passed through the bile ducts and escaped into the bowel, it may give rise to symptoms of intestinal obstruction. This may be simply from mechanical obstruction and damage to the bowel from a large concretion;

or it may be due to volvulus of the small intestine caused by the increased peristalsis produced by the passage of the stone; or it may be due to a local peritonitis, causing paralysis, and later on narrowing of the intestinal tract.

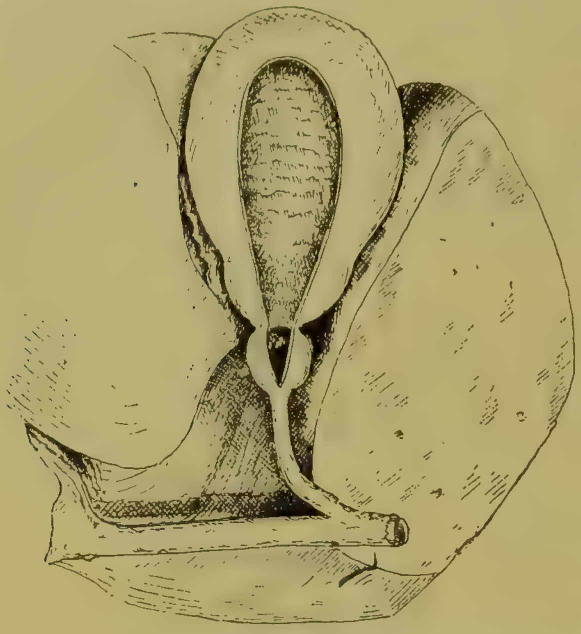

Fig. 325.—Gall stone impacted in cystic duct. (From the Museum of St. George's Hospital.)

The **surgical treatment** of gall stones.—After medical treatment has been fully tried and failed in cases of gall stones, surgical measures should be resorted to. The principal indications for operative interference are as follows: (1) in cases of recurring biliary colic, which have resisted medical treatment, with or without enlargement of the gall bladder, and unaccompanied by jaundice; (2) in enlargement of the gall bladder, without jaundice, even if unaccompanied by much pain; (3) in persistent jaundice, where there are attacks of pain, accompanied by exacerbations of the jaundice; (4) in empyema of the gall bladder, or abscess in its neighbourhood; (5) in biliary fistulæ.

It is often impossible to say what operative proceedings will have to be undertaken until the abdominal cavity has been opened. They may be comprised under the following: (1) cholecystotomy, (2) choledochotomy, (3) cholecystenterostomy, (4) cholecystectomy.

1. **Cholecystotomy** is undertaken for the purpose of draining the bladder or removing calculi (cholelithotomy). The patient is placed in the supine position with a firm pillow or sandbag under his back at the level of the liver, so as to bring the gall bladder and ducts forwards, and at the same time to cause the intestines to slip away from the liver. An incision is made in the right semilunar line, from the ninth costal cartilage downwards for about four inches. This may be supplemented, if more room is required, by a transverse cut across the rectus. In cases of long-standing jaundice the bleeding may be troublesome, and Mayo Robson advises the administration of 30 grains of chloride of calcium every four hours for a few days before the operation, to make the blood more plastic. When the abdomen is opened, the peritoneal cavity around the gall bladder is packed with sponges, and the gall bladder, if distended, is aspirated and the fluid withdrawn; as this is being done, it is pulled up to the surface of the wound and incised. The finger is introduced through the opening, and any stones which may be present are removed with a scoop or forceps. After the cavity has been cleared, the forefinger is passed along the outside of the ducts, when, if any concretions are present in them, they will readily be detected through the wall of the duct. If they are in the cystic duct, they may be sometimes manipulated backwards into the gall bladder and removed, or they may be extracted with a small scoop,

introduced through the gall bladder; but if this is impossible, or if they are situated in the common duct, other measures will have to be adopted, which will be considered immediately. Supposing that the bile ducts are free—and this may be proved by filling the gall bladder with warm sterilised water and seeing whether it escapes through the ducts, or by passing a No. 1 gum elastic catheter down the ducts—the edges of the wound in the gall bladder are united to the parietal layer of the peritoneum and aponeurotic layer, but not to the whole thickness of the abdominal wall, in order to avoid all chance of a fistula forming; and a non-perforated drainage tube having been inserted, the rest of the abdominal wall is closed. The tube should be removed in from four days to a week, when the discharge from it consists only of a small quantity of mucus and bile, and has become sterile and free from organisms. Latterly there has been a tendency on the part of surgeons to close the opening in the gall bladder at once, by separately suturing its different coats and returning it into the cavity without fixing it to the abdominal wall, and then closing the abdomen. This should only be done when there is abundant evidence that the ducts are clear, and the gall bladder and ducts are apparently normal and not inflamed. It may be also advantageously done in cases where the gall bladder is contracted and cannot be brought up to the surface. The opening in the gall bladder must then be closed in situ by long slender needles on handles; or the parietal peritoneum must be tucked down and united to the edges of the wound in the gall bladder, so as to form a continuous tube of peritoneum, and shutting off the open gall bladder from the general peritoneal cavity. Mr. Mayo Robson and Mr. Barker recommend shutting off the general peritoneal cavity by utilising the free border of the great omentum; this is sutured to the wound in the gall bladder and to the parietal peritoneum, thus forming a sort of funnel-shaped tube of peritoneum, in which a drainage tube is inserted.

2. **Choledochotomy, cholelithotrity,** &c.—When the gall stone is impacted in the cystic or common duct, and it is found impracticable to remove it by the means mentioned above, several plans of treatment may be resorted to. In the first instance, an attempt may be made to crush the stone with the finger and thumb through the walls of the duct; or padded forceps have been used, but there is danger with this instrument of seriously damaging the duct. Secondly, needling the concretion through the wall of the duct has been tried, but this plan is not advisable, on account of the danger of almost unavoidable damage to the duct and the risk of infection. If, therefore, the calculus cannot be crushed by the fingers, the safest plan is to incise the duct over the stone and remove it, subsequently suturing the opening in the duct. The incision in the duct should be closed by sutures in two layers; first the muscular and fibrous coats, then the serous membrane; and the operation is best done with a rectangular cleft palate needle.

When the stone is lodged in the diverticulum of Vater, close to the duodenum, if it cannot be pressed into this tube, it may be reached by an opening in this portion of the bowel.

3. **Cholecystenterostomy.**—When the patency of the common duct cannot be restored, either on account of the inability to remove the impacted calculus, or on account of the stricture to which the calculus has given rise, an artificial communication should be made between the gall bladder and the intestine, preferably the duodenum, though the jejunum or even the colon may be utilised. The operation is best

performed with Murphy's button, except in those cases where the gall bladder is too contracted to admit of the introduction of the button. The button is applied in the usual way (page 823), and the mode of procedure will be made clear by the accompanying figure, copied from Murphy's paper in the 'Chicago Clinical Review' (fig. 326).

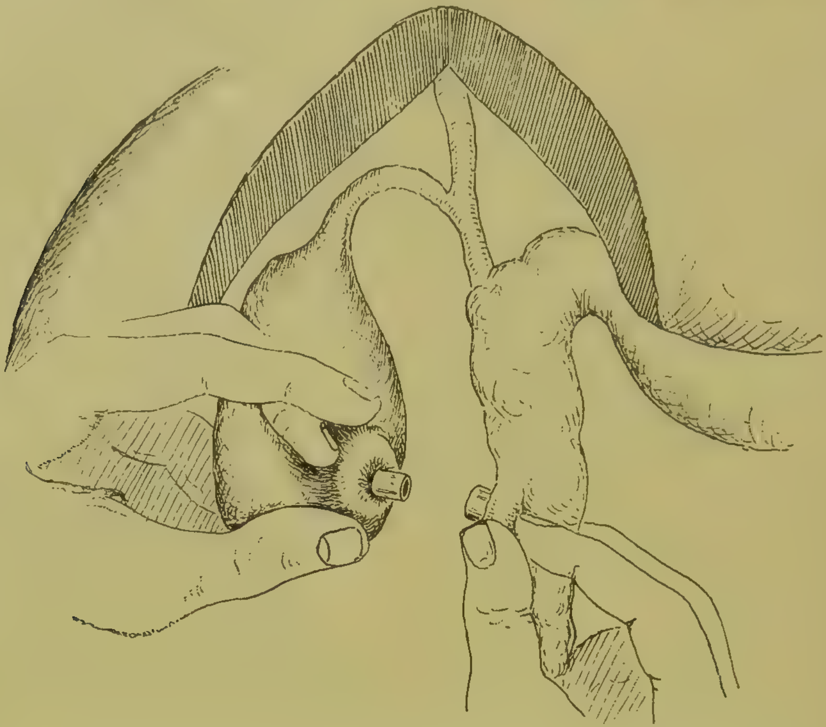

FIG. 326.—Cholecystenterostomy by means of Murphy's button.

4. **Cholecystectomy,** or removal of the gall bladder, may be required for injury; in some cases of malignant disease; in acute cholecystitis, accompanied by gangrene; in chronic cholecystitis, when it is shrunken; and in fistula, with stricture of the cystic duct. The organ is isolated with a blunt director as far as the duct; this is ligatured and divided, and after being asepticised, is sequestrated by suturing the peritoneum over the end of the duct.

Tumours of the gall bladder and bile ducts are usually malignant, though cases of adenoma and papilloma are sometimes described, occurring in association with gall stones; and these appear to have a tendency later on to assume a malignant type. The most common form of malignant disease of the gall bladder and ducts is the columnar-celled carcinoma, originating in the mucous glands; but spheroidal carcinoma, squamous-celled epithelioma, and primary sarcoma are also described.

The **symptoms** are those of a rapidly growing tumour in the region of the gall bladder, with pain and progressive emaciation. There is persistent and marked jaundice, and this it is which distinguishes it from the intermittent jaundice and occasional attacks of severe pain in gall stones.

Treatment.—The operative treatment of these cases is not very satisfactory, as the disease is usually too far advanced, when the abdomen is explored, to permit of its removal. When practicable this should be done, and in those cases where it is not possible to remove the growth, the gall bladder should be opened and drained, when it is distended.

AFFECTIONS OF THE SPLEEN

Enlargement of the spleen.—The spleen is often very considerably enlarged in cases of malaria, constituting the so-called *ague cake*, and also in one form of leucocythemia. Enlargement of the spleen is also found in rickets and in lardaceous disease. In these cases the margins of the enlarged organ can generally be made out, and there is an increased area of dullness. The organ descends on inspiration, and it can be differentiated from enlargement or tumour of the kidney by its general shape, and by the absence of the colon in front of it. Cases of enlargement due to leucocythemia are not amenable to surgical treatment, as the operation of removal is almost invariably fatal from hæmorrhage; but in cases of enlargement in malaria, which have resisted medical treatment and are accompanied by grave cachexia, the operation of removal is sometimes attended by great benefit, though the percentage of mortality is very high.

Abscess of the spleen is most frequently the result of pyæmia, but it may also follow an injury. It presents the ordinary symptoms of deep-seated suppuration, and may either point in the left hypochondrium or burst into the peritoneal cavity or into the intestinal canal.

Floating spleen.—Excessive mobility of the spleen appears to be due in a considerable number of cases to the formation of some abdominal tumour which drags upon it, stretching its ligaments and causing them to yield; in some cases, however, it is congenital, and tight lacing has been said to give rise to it. It is certainly more common in women than in men. It gives rise to pain in the back; a sense of uneasiness and discomfort after walking; colic and dyspepsia. Upon examination a movable tumour can be felt, sometimes as low as the iliac fossa, which can be recognised as the spleen by its shape and by the sharp thin anterior border, which is frequently notched. Occasionally the elongated pedicle through which the vessels run may become twisted, producing very acute symptoms of peritonitis. The treatment consists in opening the abdomen and fixing the spleen to the diaphragm by sutures, or removing the organ.

Tumours of the spleen.—New growths in the spleen are generally malignant, primary sarcoma being the form usually met with, but secondary carcinoma also occurring. Of innocent tumours, cysts are the most common. They may be hydatid, or degenerated angioma, or cysts of doubtful origin. Some of these cases may be treated by incision and drainage.

Splenectomy.—Extirpation of the spleen may be required for injury, for movable spleen, for malarial enlargement, for cysts which cannot be cured by incision, and in the early stage of primary sarcoma. The operation is best performed in the left semilunar line. The abdomen is opened and the spleen explored. If there are numerous adhesions, it is wiser to at once abandon the operation, for all torn adhesions bleed freely and render the operation dangerous. When it is decided to proceed with the removal, the organ is gently raised out of the wound, taking great care not to drag on the pedicle. The pedicle is then tied or clamped, and the tumour cut away, each vessel being again separately tied for greater security. The great danger is recurrent hæmorrhage.

AFFECTIONS OF THE PANCREAS

Cysts of the pancreas.—The only affection of the pancreas which is amenable to surgical interference, and which therefore requires mention, is *cyst of the pancreas.* The origin of these cysts is obscure; by some they are believed to be due to retention from occlusion of one of the smaller ducts, by others they are believed to be traumatic. They may occur at any age, but are most common in males of about middle life. The cyst wall is usually thin, and the fluid contents turbid and sometimes brownish from the admixture of blood; it contains the pancreatic ferments and has the power of emulsifying fat. The cyst generally occupies the lesser peritoneal cavity, with the lesser omentum and stomach in front of it, and the transverse meso-colon below; but it may be situated between the folds of the transverse meso-colon, or may project into the general peritoneal cavity.

The **symptoms** consist in the occurrence of spasmodic epigastric pains, with the presence of a slowly growing tumour in the epigastric region. The tumour is deeply situated, tense, and elastic, and fluctuation is only rarely to be felt. The stomach is situated in front of the swelling. There is often a good deal of mental depression and disquietude; the skin is earthy and pigmented. In some cases there is emaciation, and the passage of fat in the stools. Jaundice is a frequent accompaniment, due, no doubt, to the pressure of the tense cyst on the common bile duct. These tumours occasionally receive a transmitted pulsation from the aorta, and must be distinguished from aneurism.

The **treatment** is by incision and drainage in the majority of cases. In some few instances, when the cyst has been situated in the tail of the pancreas, it has been removed.

An incision in the linea alba is made, and the cyst exposed; if necessary, by dividing the two anterior layers of the great omentum. The rest of the peritoneal cavity having been shut off by sponges, the cyst is aspirated and the wall drawn forwards and sutured to the parietal peritoneum. The cyst is now opened up freely, its cavity sponged out and drained with a tube or strips of gauze.

Peri-pancreatic cysts.—Occasionally cysts are found in the neighbourhood of the pancreas, which differ from pancreatic cysts in not containing any pancreatic ferments. These may be hæmorrhagic cysts, caused by injury, or they may be localised effusions, the result of pancreatitis, which have become encysted. They cannot be diagnosed from the true pancreatic cyst before exploration, and the treatment is the same.

AFFECTIONS OF THE INTESTINES

Perforation of the intestine.—Perforation of the intestine may arise from many causes. (1) From the impaction of a foreign body, as a pin or fish bone, which subsequently perforates the coats of the intestine; or some larger body, as a tooth plate, which becomes impacted and causes ulceration and eventually perforation. (2) From a duodenal ulcer, which may be a complication of a burn or scald (page 106), or may occur spontaneously, much in the same way as a gastric ulcer. (3) From a tuberculous ulcer, following tuberculous disease of the intestine. (4) From a typhoid ulcer in cases of enteric fever. (5) From acute enteritis after strangulated hernia. (6) From the giving way of the intestine where it has been compressed by the stricture in strangulated hernia, or by a band in acute intestinal obstruction. (7) From ulceration induced by the pressure of an accumulation of fæces in chronic obstruction; this last variety usually occurring in the large intestine as the result of malignant disease.

In most cases the perforation is acute, and is attended by intense pain in the abdomen and sudden collapse, followed by tympanitis and other symptoms of general peritonitis. In the typhoid ulcer the perforation usually takes place about the third week of the disease. The patient is suddenly attacked with severe pain, accompanied by a fall in the temperature and evidence of shock, and this is followed by distension. There is usually only one perforation. The treatment which has been recently adopted with success in several cases is to open the abdomen, and either close the ulcer by invaginating a tuck of the bowel, and suturing the two folds by Lembert's suture, as in perforation of the stomach, or in making a temporary artificial anus by stitching the intestine around the perforation to the peritoneum at the margin of the wound. The remedy is a severe one, but death must certainly follow if this course is not adopted.

In some cases, especially in tuberculous ulcers and in ulcers following malignant disease of the colon, the lesion is more chronic, and under these circumstances adhesions form around the site where the perforation is about to take place, and when extravasation occurs the exuded material is shut off from the general peritoneal cavity and a localised abscess is the result, which may burst externally and will then give rise to fæcal fistula.

Fæcal fistula.—A fæcal fistula is where there is a small communication between the interior of the bowel and the surface of the body. It must not be confounded with artificial anus, where the communication is large and results from the destruction of a considerable portion of the wall of the bowel.

Fæcal fistula may arise from several causes: (1) from injuries, such as gunshot wounds, stabs, and surgical operations; (2) from any form of perforation of the bowel, but especially from tuberculous ulcer or from perforation above a cancerous stricture, or after strangulated hernia; (3) from tuberculous peritonitis, where coils of intestine become matted together, and among them an abscess forms, which may open into the bowel and also externally, and subsequently contracts and forms a fistula. (4) Fæcal fistula may also result from perforation of the appendix in cases of appendicitis. These cases will be considered later on. (5) Finally, it may be congenital (page 807). In some instances the bowel may be closely adherent to the abdominal parietes, and the opening in the skin passes directly into the bowel. In other cases the orifice in the bowel may be at a considerable distance from the surface, and the two openings may communicate by a long and sinuous track. Occasionally there may be several orifices on the skin surface communicating with the one opening in the gut. In fæcal fistula there has usually been very little destruction of the wall of the bowel, and therefore very little deflection of the gut, so that there is no impediment to the onward passage of the contents of the bowel, and only a small amount of fæcal matter escapes through the opening (fig. 327, A); but in artificial anus there has been a considerable destruction of the coats of the intestine, and therefore the bowel is sharply angled at the point of attachment to the abdominal wall; this causes the mesenteric borders of the bowel to be almost parallel with each other, and to project up to the level of the opening, forming a sort of diaphragm, which is called the *éperon* or *spur*, and this prevents the passage of the fæcal matter into the lower compartment of the tube, but directs it rather through the external orifice (fig. 327, B). Hence it follows that in artificial anus the whole or almost the whole of the fæcal matter is discharged externally. On this account a fæcal fistula has a greater tendency to heal spontaneously than an artificial anus, especially when it originates from injury. The treatment in the first instance should be strict cleanliness; preventing the discharge from the bowel irritating the edges of the fistula as much as possible by ordering that form of diet which will leave as little débris as possible, and by administering internal antiseptics (salol gr. v ter. die). When these means do not cause the closure of the fistula, the application of the actual cautery to the edges of the opening may be tried, and if this fail the parts immediately surrounding the fistula may be excised, and the opening in the gut closed with a Czerny-Lembert suture.

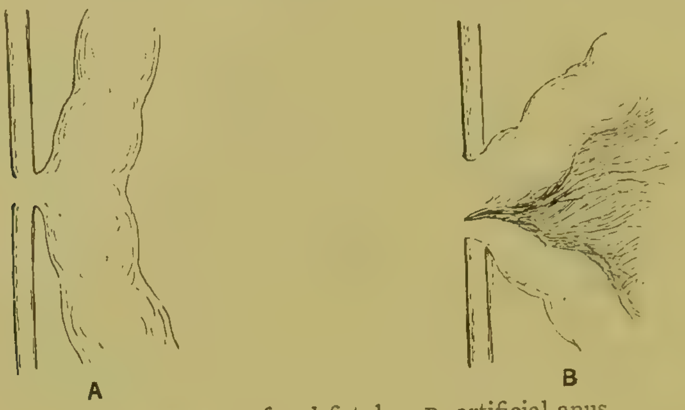

FIG. 327.—A, fæcal fistula; B, artificial anus.

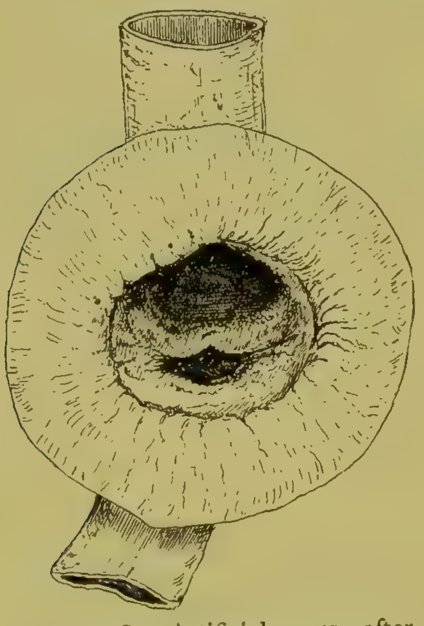

FIG. 328.—Artificial anus after colotomy. (From the Museum in St. George's Hospital.)

Artificial anus is produced in those cases where there has been considerable destruction of the gut, as in a case of strangulated hernia, where the herniated portion of the gut has sloughed and the margins of the living gut around become adherent to the external wound. In these cases an éperon or spur is formed, and on looking into the opening two tubes are seen, separated from each other by a partition, so as to present the appearance of the muzzle of a double-barrelled gun (fig. 328). Of these tubes the lower one—that is to say, the one connected with the portion of bowel below the opening—is generally smaller than the upper. These cases of artificial anus show no tendency to heal, because the fæcal contents find their way out through the external opening, and as long as the spur remains the condition is incurable. They are often the source of great discomfort and distress to the patient, for, as a rule, he has no control over the discharge of the fæces, and in many cases prolapse of the bowel to a very considerable extent takes place through the opening. Further, the constant irritation of the skin from the fæces flowing over it produces eczema. If the upper part of the small intestine is the part involved, the patient undergoes a process of semi-starvation, because the greater part of the contents of the tube is discharged before absorption of its nutritive elements has taken place.

To remedy this defect one of two operations may be undertaken. The old-fashioned plan had for its object the destruction of the éperon, so as to permit the passage of fæcal matter directly from the upper to the lower bowel. This was effected by the gradual pressure of Dupuytren's enterotome. This instrument consists of two blades, which can be approximated by a screw (fig. 329). One blade is passed up each tube, and the two are then brought together by the screw, thus embracing the spur. This causes the spur to ulcerate, and eventually the instrument drops off. The contents now pass from the upper bowel into the lower, and the external wound may heal of itself; or, if not, it may be closed by a plastic operation. The other operation consists in the resection of the involved piece of bowel. The abdomen is opened; the portion of bowel implicated is isolated and removed, and the two cut ends united by end-to-end anastomosis. The advantage of this operation is that the dangers of it can be to a great extent guarded against, whereas in the former operation there are dangers which are beyond the control of the surgeon: a coil of bowel may lie in the receding angle between the two coils of intestine and may be nipped by the enterotome, or adhesion between the two coils of intestine may be imperfect, and when the instrument separates fæcal matter may escape into the peritoneal cavity and fatal peritonitis be set up.

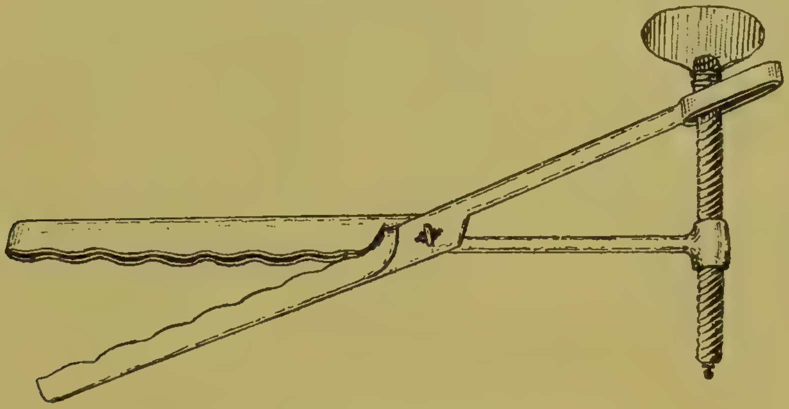

FIG. 329.—Dupuytren's enterotome.

In some cases of artificial anus, especially when it has originated from the sloughing of the gut in femoral and inguinal hernia which has become strangulated, it is hazardous to attempt to resect the damaged portion of the bowel, on account of its close relation and adhesion to surrounding structures. If this is found to be the case, after the abdomen has been opened, a lateral communication should be made between the bowel above and below the opening by the operation which is known as short circuiting or lateral anastomosis. An attempt may subsequently be made to close the external opening by a plastic operation.

Lateral anastomosis, in addition to these cases, may also be required for stricture, innocent or malignant, which cannot be otherwise dealt with. A portion of bowel above and below the stricture is made to communicate, so that the fæcal contents flow directly from the one to the other without passing over the strictured part of the bowel. As mentioned above (page 801), some surgeons prefer to unite two severed portions of gut by lateral rather than by end-to-end anastomosis.

The operation is exactly analogous to gastro-enterostomy, and may be performed in the same way; by suture, or by Senn's plates or Murphy's button. The method by suturing is probably in most cases the best, and can generally be done, for it can be carried out at a time when the patient is in a condition to bear a protracted proceeding. Halstead's method is probably the most efficient way of performing it. This method has already been described, and will easily be understood by referring to fig. 320. The methods by Senn's plates or Murphy's button are conducted exactly in the same way as in gastro-enterostomy.

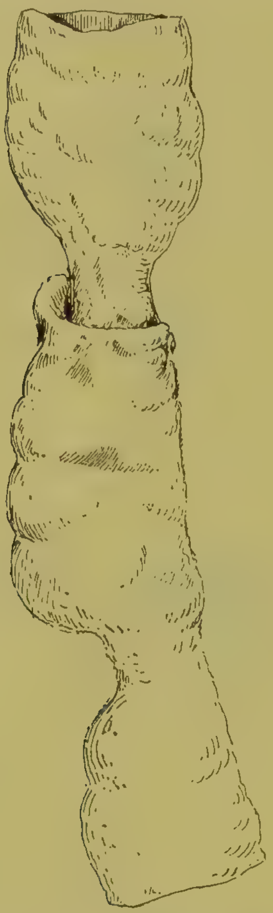

Fig. 330.—Stricture following tuberculous ulceration of the intestine. (From the Museum of St. George's Hospital.)

Stricture of the intestine.—A stricture of the intestine may be either cicatricial or malignant.

Cicatricial stricture is the result of previous ulceration, in which the scar tissue formed in the process of healing contracts and causes stenosis of the gut (fig. 330). Cicatricial stricture may therefore arise from many causes. The most common cause of stricture of the small intestine is tuberculous ulceration. Typhoid ulceration is not often followed by stricture; probably owing to the fact that the typhoid ulcer is usually elongated in the long axis of the gut, whereas those ulcers which produce stricture are most frequently transverse to the gut, or extend more or less transversely around it. In the large intestine the most common form of cicatricial stricture is that caused by the dysenteric ulcer; but syphilitic stricture of the rectum is not uncommon. Among less frequent causes of cicatricial stricture are the contraction of ulcers formed by the impaction of foreign bodies or fæces, lesions following the separation of a gangrenous intussusception, and strangulation of the bowel in hernia. Finally, wounds or other injuries of the bowel may lead to stricture.

Symptoms.—When the stricture is in the small intestine, the symptoms at first are very obscure. The patient complains of pain and discomfort, especially after taking food, and this goes on for some time until at last, owing to the narrowed portion becoming blocked by a mass of undigested food, obstruction becomes complete; then there is constipation, nausea and vomiting, but usually no tympanitis. This attack can generally be overcome by purgatives, and there is an interval during which all symptoms of obstruction subside, though the dyspeptic troubles remain. After a longer or shorter time a second attack occurs, and a third; each attack being more severe and more difficult to overcome than the preceding one. This goes on until at last an attack of complete obstruction comes on, which cannot be overcome by medicine, and the patient, unless relieved by operation, dies; or without absolute obstruction occurring he may die worn out and exhausted by repeated attacks of constipation, vomiting, and pain. In the diagnosis of these cases some clue may be obtained from the previous history of tuberculosis, hernia, injury, &c.

When the stricture is in the large intestine there are the same attacks of obstruction from time to time, but the symptoms of these attacks vary somewhat: constipation is the prominent sign, and vomiting less pronounced; it does not come on so early, is not provoked by food, and is not fæculent. The abdomen usually becomes distended with flatus, and the coils of intestine can be seen in movement through the parietes.

Treatment.—Much may be done in the earlier stages for the relief of the patient. Careful dieting, so that the food taken shall leave as little solid residue as possible, is essential. The bowels must be kept loose by laxatives, of which none is so useful as a teaspoonful of castor oil every morning if the patient will take it. Massage applied daily to the abdomen is also extremely beneficial, and large enemata should occasionally be administered, especially when the stricture is in the large intestine. It is a good plan in these cases to give a five-grain dose of salol twice or thrice a day, so as to check decomposition in the bowel. Sooner or later, however, complete obstruction will come on—an obstruction which cannot be relieved by medical means—and surgical interference will be called for. This will be considered under the heading of Intestinal Obstruction.

Malignant stricture of the intestine.—Malignant stricture of the intestine is usually a primary disease, and is due to the growth of a columnar epithelioma. It most commonly occurs in the form of a ring which encircles the gut, forming a tough indurated mass, which speedily becomes ulcerated and forms an ulcer with thick everted edges, and by its contraction constricts the bowel (fig. 331). Malignant stricture is much more common in the large intestine than in the small; its most frequent seat is the rectum, then the sigmoid flexure, and the higher one ascends in the intestinal tract the less frequent is its occurrence. The disease in the coats of the bowel speedily extends to neighbouring parts, and the growth becomes fixed: the mesenteric glands become involved, and secondary growths may appear in the liver and elsewhere. Not infrequently suppuration takes place about the growth, due to the bacillus coli communis finding an exit through the ulcerated surface; an abscess forms and

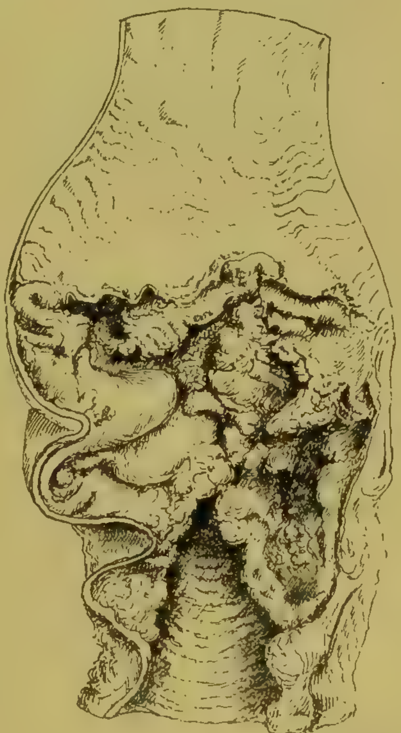
FIG. 331.—Malignant stricture of the intestine. (From the Museum of St. George's Hospital.)

tracks its way to the surface, very frequently at the umbilicus; this is opened or allowed to burst, and a fistula is formed.

The **symptoms**, in the early stage, are much the same as those which arise from cicatricial stricture; first dyspeptic symptoms, and then attacks, at intervals, of more or less complete obstruction, these attacks increasing in severity, until at last they culminate in complete obstruction, which cannot be overcome by medical means.

The **diagnosis** between cicatricial and malignant stricture is made by attention to the following points; (1) the age of the patient, cicatricial stricture occurring usually in early middle life, malignant stricture rarely occurring before fifty; (2) the history of the patient, cicatricial stricture being usually preceded by a history of tuberculosis, dysentery, hernia, intussusception or injury; (3) the more rapid progress of the disease in the malignant form, and the greater and more speedy emaciation; and (4) the presence of a tumour, which can generally be detected in the malignant form; at first movable, but after a time becoming fixed.

Treatment.—The treatment in these cases must vary according to the condition of parts which is found upon opening the abdomen. The ideal treatment is to resect the portion of the bowel which is the seat of the disease, and join the two severed ends by one of the forms of enterorrhaphy mentioned above (page 797 *et seq.*). This, however, is not often possible; by the time that the symptoms are sufficiently clear to make a diagnosis, the growth has attained such a size, and has become so fixed to neighbouring parts, as to render it impracticable. If this is the case, merely palliative measures can be adopted, and these measures are of such a nature that they give great relief to the patient and materially prolong life. If the repeated attacks of partial obstruction are prevented, and the ulcerated surface no longer irritated by the passage of the fæcal contents over it, the progress of the growth is slow, and cases have been recorded where the patients have lived four years and more after this has been done. Several methods may be adopted.

1. The bowel may be short-circuited by making a lateral anastomosis between a coil of intestine above the growth, with one below. The intestinal contents then flow through the communication, without reaching the strictured part, and all fear of obstruction is removed.

2. The bowel may be divided completely across above and below the diseased portion, and the two ends joined by end-to-end anastomosis. The upper end of the severed portion is then closed by a Czerny-Lembert suture, and the lower end attached to the external wound to allow of the escape of mucus and discharge from the ulcerated surface. This plan of treatment is not to be recommended, as it leaves a permanent fistulous opening, which is constantly discharging, and is a source of annoyance and discomfort to the patient.

3. The gut may be completely divided on the proximal side of the diseased portion, and the upper cut end united to the edges of an incision made into the gut below the diseased portion, the lower end of the divided portion being closed by a Czerny-Lembert suture. This mode of treatment is particularly adapted to cases of cancer of the cæcum, when this portion of the intestinal canal is too fixed to be capable of removal. The ileum just above the ileo-cæcal valve is first divided, and the upper cut end is sutured to the edges of an opening made in the ascending colon, while the lower end is permanently closed.

4. When the disease is situated in the large intestine, an artificial

anus may be made. This proceeding is not adapted to strictures in the small intestine, as an artificial anus in the small intestine, especially high up, leads to death from malnutrition. This plan of treatment should only be resorted to when none of the other measures are applicable, or where, on account of the patient's condition, they cannot be undertaken.

INTESTINAL OBSTRUCTION

The term **intestinal obstruction** is variously used. In this place it will be employed to denote those cases where there is a complete arrest to the passage of fæces and flatus along the intestinal canal from some mechanical cause, and therefore will not include those cases where the arrest is due to some nervous influence, as in paralysis of the gut in acute peritonitis, or in enteritis following the reduction of a strangulated hernia, &c. Nor will it include those cases where the passage of the fæces and flatus is arrested in consequence of the protrusion of a portion of the gut through some normal or abnormal opening in the abdominal wall. These cases will be considered separately under the head of Hernia.

The arrest of the passage of the fæces and flatus through the intestinal canal from mechanical causes is attended by certain local and constitutional changes.

The **local changes** are mainly due to venous congestion of the gut at the site of obstruction. In consequence of the interference with the venous circulation, the part becomes loaded with black blood, and then inflamed, and this causes such damage to the walls of the gut that the bacteria of the intestine (bacillus coli communis) escape through them, and peritonitis, either local or general, is set up. The venous congestion, if the cause is not removed, goes on to gangrene, and subsequently ulceration and perforation. If the cause of the obstruction is removed early enough relief follows, the venous congestion subsides, the peritonitis is arrested, the peristaltic action of the intestine returns, and the fæces pass on in the natural way. But it may happen that the obstruction has not been removed until such time as irretrievable damage has been done to the gut; then the venous congestion continues, the gut remains paralysed, no return in the peristaltic movements takes place, and ulceration and perforation follow.

The **constitutional symptoms** depend upon the absorption of the decomposing intestinal contents, the inability to take food, and the exhaustion induced by the constant vomiting, so that they are characterised by rapidly increasing weakness and exhaustion, failure of the heart's action and respiratory centres, and death from asthenia.

It is convenient to consider intestinal obstruction as an acute and chronic condition, but it must be borne in mind that the same mechanical obstruction may give rise to either one of these two conditions.

Acute intestinal obstruction.—Several different causes may give rise to an acute obstruction in the intestine. They may be classified as follows: (1) internal strangulation of the bowel; (2) volvulus; (3) stricture; (4) foreign bodies; and (5) intussusception.

1. **Internal strangulation of the bowel.**—These are cases where the bowel is compressed, so as to arrest its circulation, by some cause within the cavity of the abdomen, such as an abnormal band, or by slipping through some normal or abnormal opening in the abdomen. They

are sometimes styled *internal herniæ*, in contradistinction to external hernia, where the bowel is compressed by slipping through some normal or abnormal opening in the abdominal wall, and where therefore the constricted portion of gut is *outside* the abdomen. One of the most frequent ways in which the obstruction is produced is by a coil of bowel, generally small intestine, slipping over and becoming entangled in a band passing from one part of the abdominal cavity to another. These bands may be formed in several ways: (*a*) they may be old adhesions, the result of former peritonitis (fig. 332); they are composed of fibrous tissue, are often of considerable length, and in many cases there is only a single band; in other cases they are multiple. The manner in which they originate is as follows: first there is a local peritonitis, caused by a tuberculous or typhoid ulcer; inflammation of a mesenteric gland; appendicitis; or injury; as a result of this, adhesion takes place between two coils of intestine, or between a coil of intestine and some other viscus or of the abdominal wall. This adhesion becomes elongated from traction, and rounded and cord-like from the constant movement of the intestine. After its formation, during some muscular effort—it may be straining at stool, or lifting a heavy weight—a coil of intestine either slips under the band and becomes strangulated; or if it is long and loose, the band forms a noose or loop by which the bowel is ensnared. (*b*) The constricting band may be formed by Meckel's diverticulum: that is, the vitelline duct remaining persistent in whole or in part. This duct, when it persists, is connected with the ileum and usually forms a short tube, to the end of which a cord-like process is attached, which may become adherent to the abdominal parietes or to one of the viscera. It thus forms a band under which a loop of bowel may be compressed, or which may form a snare around a coil of intestine. (*c*) An appendix epiploica may become adherent to the abdominal wall or to some viscus, or two appendices epiploicæ may become adherent together (fig. 333), and so form a band or noose in which a portion of bowel may be strangulated; or in

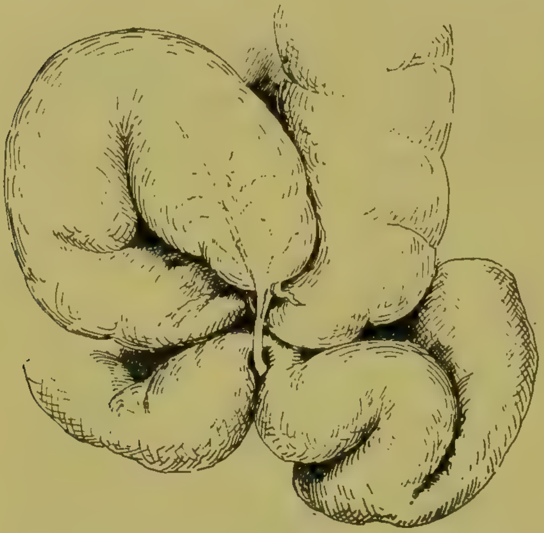

FIG. 332.—Strangulation of the intestine by a band. (From the Museum of St. George's Hospital.)

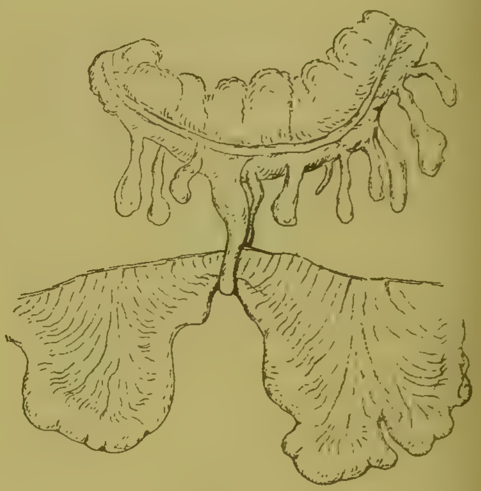

FIG. 333.—Strangulation of intestine by two adhering appendices epiploicæ. (From the Museum of St. George's Hospital.)

the same way the omentum, or the vermiform appendix, or a Fallopian tube may become adherent to the abdominal wall or some other viscus, and so form the constricting band.

In other cases of internal strangulation the compression of the gut may be produced by a coil of bowel slipping through some normal or abnormal opening and becoming compressed by the free border of the opening. Among the normal openings are the foramen of Winslow, the strangled portion of gut being then herniated into the lesser bag of the peritoneum; and certain constrictions in the peritoneum leading into pouches, of which the duodeno-jejunal fossa, the inter-sigmoid fossa, a pouch in the sigmoid meso-colon, and the ileo-cæcal fossæ, are the principal.[1] Abnormal openings are usually slits or openings in the mesentery or omentum, which may be either congenital or acquired, or in rarer cases slits in the broad ligament of the uterus or the suspensory ligament of the liver.

2. **Volvulus.**—By this term is meant a twisting of the gut on itself in such a manner that there is an obstruction to the passage of the contents of the tube. This twisting may take place in three ways. By far the most common form is for a coil of intestine to become twisted on its mesenteric axis (fig. 334, A), but in some instances it was twisted on its longitudinal axis, like a screw (fig. 334, B), and in very rare instances it has been stated that one coil of intestine was twisted round another. Volvulus may affect any part of the intestinal canal, but is most commonly met with in the sigmoid flexure of the colon. The condition in this situation is predisposed to by the shape of the flexure, which, as Mr. Treves has pointed out, forms with the upper part of the rectum a large loop or bend, like the Greek letter Ω (omega), in which the ends of the loop are brought closely together. It is further induced by the meso-colon being elongated, either congenitally or more commonly as the result of habitual constipation. Any irregular action of the intestine or movement of the abdominal wall with the gut in this condition may tend to cause a rotation, and so produce a volvulus. As the twist tightens, the circulation is interfered with, and the

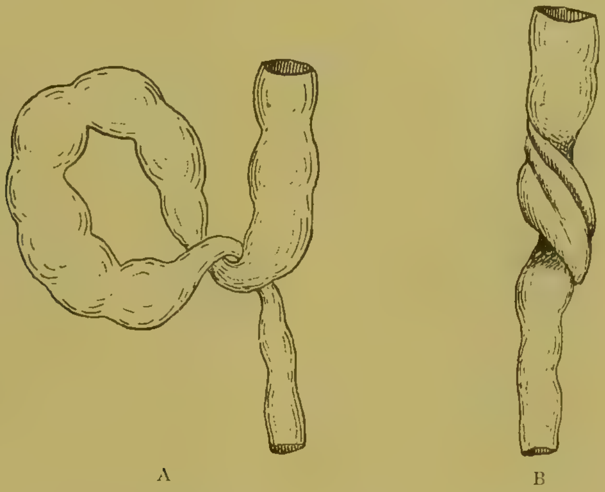

FIG. 334.—Diagram showing the two most common ways in which a volvulus may occur.

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[1] These cases constitute what is known as post-peritoneal hernia, and will be considered in the section devoted to Hernia.

loop becomes strangulated, and if the patient lives long enough sloughing and perforation may follow. The ascending colon is sometimes the seat of volvulus; this occurs when there is congenitally an elongated meso-colon (fig. 335). Volvulus of the small intestine is usually due to the violence of the peristaltic movements in an acute attack of biliary colic, or from the presence of a gall stone in the intestinal tube, causing violent expulsive efforts.

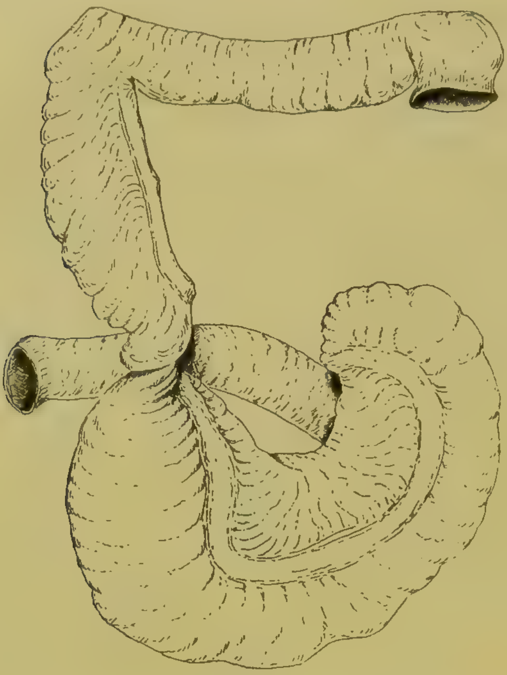

FIG. 335.—Volvulus of ascending colon. (From the Museum of St. George's Hospital.)

3. **Stricture.** — Stricture of the intestine may sometimes be a cause of acute intestinal obstruction. There is a gradual narrowing of the tube from some malignant growth or cicatricial contraction, which may give rise to the symptoms enumerated above (page 838), and then sudden symptoms of acute obstruction come on, which cannot be relieved by medicine. These are due to the impaction of a fæcal mass in the narrowed part, or to some bend or kink in the gut taking place in this situation, or possibly they may arise from swelling due to inflammatory exudation taking place around the site of stricture.

4. **Impaction of foreign bodies.**—The most common form of foreign body which becomes impacted in the intestinal canal, and gives rise to symptoms of obstruction, is a gall stone. It is generally believed that in these cases the gall stones have not found their way down the bile ducts into the duodenum in the ordinary manner, because under these circumstances they would be so small that they would have no difficulty in passing down the intestinal canal, but that they are larger stones, which have ulcerated from the gall bladder into the duodenum. They usually become lodged in the lower part of the ileum, and are more common in females than in males. Another foreign body which may become impacted in the gut and give rise to symptoms of obstruction is an intestinal concretion; that is, a phosphatic deposit around a nucleus composed of some undigested substance or foreign body, or a mass of some indigestible material, such as hair or vegetable fibres, which becomes matted into a ball by the peristaltic action of the intestine, and mixed with fæces and earthy matter. Finally, foreign bodies which have been swallowed, and which have passed out of the stomach through the pylorus, may become arrested in the intestine and cause obstruction. The most common of these are plates of false teeth, the projecting claws of which become entangled in the mucous membrane, and arrest their onward progress.

5. **Intussusception** is another cause of acute intestinal obstruction, though it is not always followed by this result, for in some cases of

intussusception the symptoms of obstruction are not marked, or they may be absent, and there may be no stoppage to the passage of the intestinal contents down the tube. By intussusception is meant an invagination or prolapse of one portion of the bowel into another. The invagination is most frequently caused by violent, irregular peristalsis, excited generally by some irregularity in the diet, or it may be by the presence of worms, or in some cases by a growth, such as a polypoid tumour (fig. 336); but it may also be caused by a mechanical shake to the bowels, as in jumping, or by a blow on the abdomen. The disease is most common in children, especially during the first year of life. In consequence of the invagination of one portion of the bowel into another, the intussusception consists of three layers of intestine (fig. 337): on the outside is the receiving tube or sheath, which is sometimes known as the *intussuscipiens* ; within this is the reflected tube, turned inside out, so that its mucous surface is in contact with the mucous surface of the ensheathing tube ; and internal to this is the entering tube, whose serous surface is in contact with the serous surface of the reflected tube ; and between them is the mesentery attached to these two portions of bowel. The reflected tube and the entering

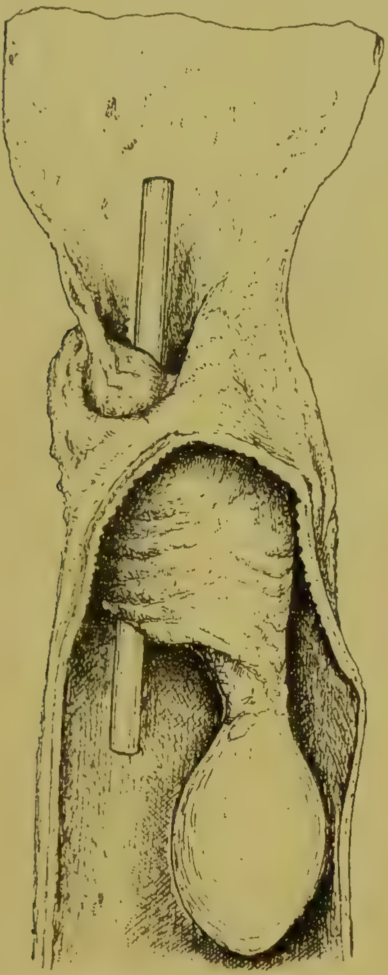

FIG. 336.—Intussusception caused by a polypus. (From the Museum of St. George's Hospital.)

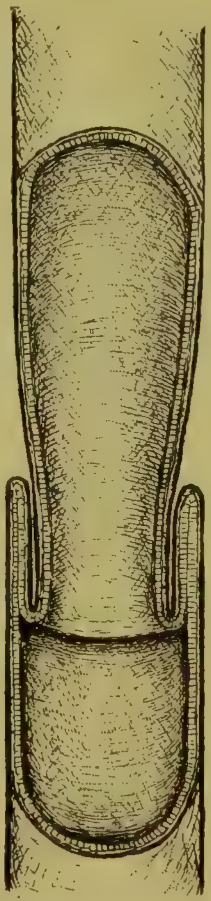

FIG. 337.—Diagram of an intussusception, showing the ensheathing, the reflected, and the entering tube.

tube are known together as the *intussusceptum.* The upper portion of the bowel is invariably invaginated into the lower. In intussusception of the small intestine into the large (ileo-colic intussusception) the invagination increases at the expense of the entering tube or small intestine. In all other forms of intussusception the invagination increases at the expense of the receiving tube; the line of reflection between the entering and reflected tubes remaining the same, whatever the length of the intussusceptum. Anatomically there are four varieties of intussusception. The most common variety is the ileo-cæcal (44 per cent. of all cases), where the ileum and cæcum prolapse into the colon, preceded by the ileo-cæcal valve which forms the apex of the intussusceptum. This variety increases at the expense of the receiving tube. The next most frequent variety is the enteric (30 per cent.), where one portion of the small intestine is invaginated into another. These intussusceptions are usually in the ileum, and are generally small. The third variety is the colic (18 per cent.), where one portion of the large intestine is invaginated into another portion of the same. This form may be found in any part of the large gut, but is most frequently situated in the sigmoid flexure. The most uncommon form is the ileo-colic (8 per cent.), where the end of the ileum prolapses through the ileo-cæcal valve. In these cases the valve retains its normal position, and more and more ileum is protruded through, so that the increase is at the expense of the entering tube. But this at last ceases; after a time no more ileum can protrude, and then if any further increase takes place it is, as in the other forms, at the expense of the receiving tube. The effects of an intussusception are first of all obstruction, though this may not be complete; this is brought about by the narrowing of the lumen of the tube from congestion of the wall, and from traction of the mesentery, which curves and partially kinks the prolapsed gut. The narrowed tube may also become blocked by a portion of undigested food, or by blood clot. Secondly, the vessels in the mesentery, which is carried along with the gut when it becomes invaginated, become constricted, and the passage of blood through them is arrested, so that the intussusceptum becomes strangulated and eventually gangrenous. Under these circumstances the whole of the intussusceptum may perish, separate at the point of invagination, and be discharged per anum, and in this way a spontaneous cure may be brought about. The cases, however, in which this has occurred, and in which recovery has taken place, are very rare; before it can take place, in many cases a diffuse peritonitis is set up from the passage of the bacillus coli communis through the damaged coats of the gut, and causes the death of the patient; and even if separation does occur, and the gangrenous mass is got rid of, stricture is likely to supervene. In those cases where a general peritonitis does not supervene and destroy the patient a limited peritonitis may be set up, and may glue together the serous surfaces of the entering and reflected layers, and thus lead to irreducibility of the intussusception.

Symptoms of acute intestinal obstruction.—The symptoms common to all forms of intestinal obstruction are as follows: in some cases the patient is seized quite suddenly with intense pain in the abdomen, which 'doubles him up,' perhaps while making some muscular effort, as in straining at stool or lifting a heavy weight, and this is accompanied by a sensation as if 'something had given way or slipped out of place.' This sudden access of pain is sometimes associated with vomiting, the contents of the stomach being at once rejected. In other cases the pain comes on somewhat more gradually. The patient is seized with a colicky pain, often referred to the navel and radiating from this point, and this pain rapidly becomes more and more intense and spreads over the abdomen. The pain, whether beginning suddenly or in a more gradual manner, is continuous, but subject to exacerbations, and is of a colicky nature. At this early period of the case it is not increased by pressure, and in fact the patient is sometimes relieved by the pressure of the hand placed upon the abdominal wall. Vomiting is an early symptom, and whether the contents of the stomach have been rejected at the time of the advent of the pain or not, persistent and copious vomiting, independently of taking food, soon sets in. The vomited matter is at first bilious and then brown and offensive, and after a time may become stercoraceous. There is a constant sensation of nausea, which is not relieved by vomiting. The abdomen becomes distended, the amount of distension varying with the seat of the obstruction. When this is situated high up in the jejunum, the distension will be slight and will be confined to the region of the stomach ; when the obstruction is low down in the ileum, the whole of the small intestine above will be distended, the tympanitis will be confined to the front of the abdomen, and the flanks will be flaccid ; and when the obstruction is in the sigmoid flexure, the whole of the abdomen, and especially the flanks, will be distended. If the patient is thin, the distended coils of intestine may be seen through the abdominal wall, but as a rule there is no movement in them In most cases constipation is absolute from the first, no matter in what part of the bowel the obstruction may be situated ; but in some few cases a motion may be passed after the symptoms have set in. The amount of the urinary secretion is usually diminished, owing to the impression made upon the nervous system, and not, as was formerly supposed, on account of the loss of fluid from vomiting. Thirst is usually intense; the tongue furred and the mouth dry. There is very marked vital depression almost from the commencement: a feeble rapid pulse, a temperature usually below normal, a cold sweat on the face, and great anxiety of countenance. There is rapid loss of strength, and if unrelieved the patient becomes collapsed, and dies within a week with symptoms of septic poisoning.

Special symptoms dependent upon the cause.—The special symptoms which are due to the cause which gave rise to the obstruction, and by which a diagnosis can in many instances be made, are as follows :

1. In *internal strangulation* there may be the previous history of peritonitis, or of an attack of severe pain in the abdomen accompanied by fever. The patients are mostly young adults, for this condition is rare after the age of forty. The advent is sudden and often takes place during some muscular exertion, and the patient is conscious of something having given way or gone wrong at the moment of seizure. There is frequently an almost immediate rejection of the contents of the stomach after the advent of the pain, and the subsequent vomiting is usually very persistent. No tumour is to be felt in the abdomen.

2. *Volvulus.*—Volvulus is most frequently situated, as already stated, in the sigmoid flexure of the colon, and under these circumstances usually occurs in males of somewhat advanced life, frequently about the age of sixty, in whom there is a history of habitual constipation. The onset is generally sudden, but the pain is not so severe, nor is the onset of vomiting so early a symptom as in internal strangulation. Great distension of the abdomen is a marked feature in these cases, and sets in early. The

descending colon is often enormously distended, and presents a well-marked tympanitic swelling in the left inguinal region.

3. *Stricture.*—When the obstruction is due to stricture, the age of the patient in the malignant form, and the previous history in the non-malignant form, must be taken into account. Malignant stricture rarely occurs before the age of forty, and is usually met with at a later age than this, and in non-malignant stricture there is generally the history of some previous ulceration of the bowels from dysentery, tubercle, &c., and in cases of stricture arising from tuberculous ulcerations there may be other indications of this condition. When the stricture is situated in the small intestine the onset of the attack is sudden, frequently coming on after the ingestion of a hearty meal; but there will be the history of previous attacks of pain, constipation, and vomiting, which have passed off or been relieved by medicine. When the stricture is in the large intestine, especially when it is low down in the sigmoid flexure, the symptoms develop slowly, there is constipation, with gradual distension, and vomiting does not set in for some time. These cases belong more, however, to the condition of chronic obstruction. When the stricture is malignant a tumour may be felt through the abdominal wall, and there may be the passage of blood per anum.

4. *Foreign bodies.*—In obstruction from gall stones, fæcal concretions, or foreign bodies which have been swallowed, the symptoms are not always very clear, though much assistance may often be obtained in the diagnosis of the case from the previous history of the patient. Repeated attacks of biliary colic, or the passage of gall stones on former occasions, or the history of some foreign body having been swallowed, would point to obstruction from this cause. If the foreign body is large it may sometimes be felt by a careful exploration through the abdominal wall, especially if the examination is made early, before the supervention of tympanitis.

5. *Intussusception.*—Intussusception is essentially the cause of acute intestinal obstruction in young children, the great majority of cases arising from this condition. The invasion is usually sudden; if the child is too young to complain it will be noticed to cry out, the legs will be drawn up, and the patient become faint and pallid, and he will probably vomit. The child then becomes manifestly uneasy; it occasionally gives a sharp cry, and draws its thighs towards the belly, as if suffering from a griping paroxysmal pain. Vomiting now sets in, but is not nearly so persistent as in other forms of intestinal obstruction; very often the child simply rejects any food taken into the stomach, but does not vomit if no food is given. There is usually not much distension of the abdomen. The two most characteristic signs are constant straining and the passage of blood and mucus from the bowel, and the presence of a tumour to be felt in the abdominal cavity. The tumour is usually elongated and sausage-shaped; it is dull on percussion; it is doughy to the feel, but under examination becomes harder, owing to the contraction of the muscular coat which is excited by the manipulation. The swelling is best detected by a bimanual examination, through the abdominal wall, with the finger of one hand introduced into the rectum. In some cases the intussusceptum reaches the rectum, and the tumour can easily be felt with the finger introduced through the anus.

Prognosis and termination of acute intestinal obstruction.—Intestinal obstruction, if unrelieved, almost invariably terminates in death. In some rare instances, as has already been mentioned, in cases of acute intestinal obstruction from intussusception, the intussusceptum may slough off and the passage be restored, at all events for a time; but with this exception acute intestinal obstruction almost invariably terminates fatally, sometimes as early as the second day, but almost always within a week or ten days. It must be borne in mind that death in these cases does not really result from the obstruction *per se*, but the patient dies poisoned by the septic matter derived from the decomposition of the intestinal contents, which is retained in the bowels. This, as will be seen, has an important bearing on the treatment of these cases.

Treatment.—From a practical point of view, the treatment of acute intestinal obstruction may be summed up in the one word—'operation.' There can be no question that if the life of a patient who is suffering from genuine acute intestinal obstruction is to be saved it can only be done by removing the cause of the obstruction; but in many cases this is not sufficient—the patient is dying from a poison which is generated in the accumulation of material in the gut above the obstruction, and if this is not got rid of, the removal of the cause of the obstruction will not be sufficient to effect a cure.

The exact procedure to be followed in these cases must vary according to the condition of the patient, but in all the first and fundamental rule is to deal with the case at once. As soon as the diagnosis of intestinal obstruction has been made, operative interference should be proceeded with; such palliative measures as the administration of opium, the exhibition of enemata, &c., can only do harm by wasting time and diminishing the patient's chance of recovery.

When the patient is in a fairly good condition, and there is no great distension of the abdomen; when the vomit is not stercoraceous, showing that decomposition of the intestinal contents has not taken place; and when there is no general indication of poisoning from septic absorption, a laparotomy should be performed in the middle line of the abdomen, and the obstruction sought for and removed. In many cases the cause of the obstruction is at once apparent upon opening the abdomen, but in others this is not so. A systematic examination should then be instituted; the hand must be introduced into the abdomen and carried down to the right iliac fossa, and the condition of the cæcum ascertained. If this is flaccid and empty, the obstruction is in the small intestine; if, on the other hand, it is distended, the obstruction is in the large. In the former case the ileum just above the ileo-cæcal valve should be found, and the small intestine traced backwards by drawing the ileum up to the surface of the wound and then passing it through the two hands until the obstruction is reached, each coil being passed back into the abdominal cavity before the next is withdrawn. If the cæcum is distended, the obstruction is very probably in the sigmoid flexure or upper part of the rectum, and the hand should be introduced into the left iliac fossa, and this portion of gut examined. If it should prove to be collapsed and empty, the colon must be traced backwards until the obstruction is reached. The obstruction having been discovered, the next step is to deal with it according to its nature. If it is a band of adhesion, the band must be ligatured in two places and divided between the ligatures; if the constriction is due to a Meckel's diverticulum, it is advisable to remove it. This may be done by clamping the gut on either side, cutting off the diverticulum, and suturing the opening thus made in the bowel with a Czerny-Lembert suture. When the obstruction is due to a knuckle of intestine slipping through a hole in the mesentery or omentum, the constricting edge may require incision before the gut can be reduced; the opening should then be closed. When the obstruction is owing to a stricture, resection of the portion of the gut may have to be performed, or a short-circuiting or artificial anus made (see page 840). If a volvulus is present, an attempt may be made to untwist it; but this is generally not possible, and even if it is untwisted there is a great tendency for it to re-form; under these circumstances it is necessary, if the volvulus is in the sigmoid flexure, to draw up the bowel above the twist, into the external wound, and make an artificial anus; if it is in the small intestine, the portion of gut involved must be excised. Where a foreign body is lodged in the bowel and is the cause of the obstruction, an endeavour should be made to alter the position of the body and push it into a more healthy part of the bowel, and then cut down upon it and remove it, subsequently closing the wound with a Czerny-Lembert suture.

After the cause of obstruction has been removed, the question arises as to whether it is desirable to evacuate the contents of the bowel, so as to prevent the further absorption of septic material; and the opinion of those who have devoted special attention to this subject appears to be in favour of this proceeding. Mr. Treves advocates it as a routine measure, and says that in his own practice it has had the effect of reducing the mortality after operation to one-half of its original rate. Certainly if there is much distension, and if the vomit has already become stercoraceous, it ought always to be done. The most distended coil of intestine is brought up to the external wound, and being carefully guarded by sponges, an incision is made into it; a glass tube, or a Paul's tube (fig. 311, G), is inserted and tied in, or fixed to the bowel wall by a single encircling thread. This tube is allowed to remain in for some days, and the artificial anus thus made can usually be easily closed after the recovery of the patient.

It sometimes happens that the surgeon is called upon to operate on a case of acute intestinal obstruction in which the patient is not in a condition to stand such an extensive operative procedure as the above: the abdomen is much distended, the vomit has been for some time stercoraceous, and there is marked vital depression, so that even the administration of an anæsthetic is fraught with danger. Under these circumstances, a few drops of cocaine should be injected under the skin over the most distended and prominent coil of intestine, and an incision made in the abdominal wall at this spot. As soon as the peritoneum is divided to the extent of about an inch or an inch and a half, the coil of intestine will bulge through the opening, and it should be at once fixed to the parietal peritoneum by a circle of sutures, care being taken not to allow it to protrude too much. An incision is then made into the bulging gut, and a glass tube introduced and tied in. Through this the fæcal contents can escape, and all search for the obstruction must be deferred till a later date, when the patient has recovered from the effects of the septic absorption. After the cause of the obstruction has been removed, the artificial anus can be closed.

Treatment of acute intestinal obstruction caused by intussusception.—The treatment of obstruction from intussusception requires special mention, as it differs somewhat from obstruction arising from other causes, especially when it occurs, as it so frequently does, in young infants. The principle of treatment is the same, that is, to remove the cause; but inasmuch as the operation of laparotomy on a child under twelve months of age is an exceedingly severe measure, and attended by a very high rate of mortality, it is desirable to consider whether other means cannot be adopted for the relief of these cases. After a considerable experience of intussusception, I have come to the conclusion that there is a certain percentage of cases which may be relieved without operation, and that the proceeding by which relief can be obtained, if carefully applied, does no harm, and does not occupy any very considerable period of time; and that therefore it is right to try these measures first, before resorting to what, on all hands, is admitted to be a very formidable operation. I look upon the treatment of intussusception as being very much the same as that for strangulated hernia. If we have to deal with a strangulated hernia which has not been long strangulated, and in which there is therefore presumably not very extensive changes in the gut, we administer an anæsthetic, apply taxis, and failing to reduce the hernia by this means, we proceed to operate. If, on the other hand, the strangulation has existed for some time, and there are evidences of local changes having taken place in the part, we operate at once, without having previously applied taxis. I would apply very much the same plan of treatment to an intussusception. In a recent case, where the invagination has not existed more than twenty-four or at most forty-eight hours, I would endeavour, by mechanical means which we may liken to taxis, to reduce the intussusception, and failing this I would at once proceed to operate. In those cases, however, where the invagination has existed for a longer time, I would operate at once, without attempting to overcome it by other means.

The mechanical methods that we have at our disposal for the relief of intussusception are: 1. inflation of the bowel with air; 2. the injection of fluid; 3. massage.

1. *Inflation of the bowel with air.*—The child is to be swathed in wool, so as to preserve its warmth, and anæsthetised. An enema pipe is introduced into the rectum and connected by india-rubber tubing to a Lund's inflator or a pair of bellows, and the pipe packed around the anus with wool to prevent the escape of air. The child is inverted, and air slowly forced into the bowel. The surgeon's hand is placed over the tumour, if one can be felt, and if the operation is successful he will suddenly feel the tumour disappear, and the air, which up to now has been confined to the colon, become diffused over the whole abdomen. The plan of treatment is, of course, inapplicable to the enteric form of intussusception.

2. *The introduction of fluid into the bowel.*—Great care must be exercised in doing this, lest any injury be done to the weakened coats of the bowel. The fluid should be introduced by irrigation, and the reservoir containing it should not be elevated more than three feet above the child's nates. The amount of fluid used for a child of one year or under should not be more than a pint and a half. The best fluid to use is a normal saline solution at a temperature of 100° F. The introduction is to be made in the same way as in inflation with air, with the child inverted, and the fluid should be retained for a few minutes and then allowed to escape. An examination of the abdomen is then to be made, to ascertain if the tumour has disappeared; if not, it is probably wiser not to renew the attempt.

3. *Massage.*—Attempts have been made by massage in the course of the colon to reduce an intussusception. I have never succeeded in reducing one by this means, though I have tried many times; but I have succeeded in reducing an intussusception in a thin child by kneading it back; first seizing the gut between the forefinger and thumb immediately below

the tumour, and then, by a series of compressions, gradually pushing the tumour backwards along the course of the colon.

In the event of none of these plans succeeding in reducing the intussusception, laparotomy should be at once resorted to. The main point in the performance of the operation is to avoid any injury to the bowel, and this is to be done by the most gentle handling, and by, as far as possible, not allowing any intestine to escape through the external wound. In the first instance, a small incision should be made, sufficiently large to admit the finger and thumb; when the peritoneum has been incised, the finger is introduced and the tumour felt for, and when found, it is carried along the colon until the lower limit of the tumour is reached. The gut is now grasped just below this by the finger and thumb, and they are gradually worked upwards along the colon, pushing the tumour before them, until the intussusception is reduced. If this cannot be done, the incision must be enlarged and the tumour brought up to the surface of the wound; the intestine is then seized between the finger and thumb below the invagination, and the intussusceptum pushed out of its sheath. No attempt should ever be made to reduce it by traction. Occasionally it happens that in cases of intussusception of long standing it is impossible to reduce it; three courses are then open to the surgeon: (1) He may resect the invaginated portion of gut, and do an end-to-end anastomosis of the two severed portions of bowel. (2) He may make a longitudinal incision into the intussuscipiens, and drawing out the intussuscepted part, cut it off and suture the intussusceptum and the intussuscipiens. This is done by Maunsell's method (see page 799). (3) He may make an artificial anus above the intussusception. This plan would probably never be adopted in the present day. It was formerly advocated because it was the most rapid way of completing the operation. Now that one of the other methods can be performed almost, if not quite, as rapidly, there is no object in doing what is a very imperfect operation, and one which leaves the patient in a sadly mutilated and distressing condition.

Chronic intestinal obstruction.—Chronic intestinal obstruction is always characterised by the slow and insidious way in which it sets in, being preceded by gradually increasing attacks of constipation, often alternating with a spurious diarrhœa or discharge of watery, fæcal-stained fluid from the bowel, set up by a condition of catarrhal enteritis induced by the irritation of retained fæces.

Causes.—Like the acute form of the disease, chronic intestinal obstruction may arise from several different causes, but in the majority of cases the cause of this condition is situated in the large intestine. They are: 1. stricture, either malignant or cicatricial; 2. tumours in the bowel; 3. fæcal accumulation; 4. foreign bodies; 5. pressure on the gut from without by inflammatory products or new growths; 6. chronic intussusception.

1. **Stricture of the large intestine,** either malignant or cicatricial, is the most common cause of chronic intestinal obstruction, and the stricture is usually situated in the rectum or sigmoid flexure of the colon. Malignant stricture is far more frequently met with than the cicatricial variety. Stricture of the small intestine, though in isolated cases giving rise to chronic obstruction, is most frequently one of the causes of the acute affection, as mentioned above, from the sudden occlusion of the narrowed lumen by the impaction of a fæcal mass or some undigested particle of food or from inflammatory swelling around.

2. **Tumours in the bowel.**—Simple tumours growing from the wall of the bowel, such as adenomata or papillomata, may give rise to obstruction. They assume a polypoid form, and may attain a great size. They are most commonly found in the colon and rectum.

3. **Fæcal accumulation.**—The accumulation of fæces in the large intestine may give rise to chronic obstruction, and the accumulation may take place from several causes: from chronic dyspepsia, often occurring in patients who are edentulous or do not properly masticate their food; from the consumption of indigestible food, which remains in the intestine and forms a sort of nucleus on which fæcal matter is deposited; or from loss of tone of the muscular coat of the bowel, from debility, old age, or the habitual use of aperients. The fæces become hard from absorption of their watery constituents, and rounded in shape, forming spherical masses, which get lodged in the sacculi of the colon and produce obstruction. The bowel is apt to ulcerate, forming the so-called *stercoral ulcer*, and perforation may take place.

4. **Foreign bodies** which have been swallowed may occasionally give rise to chronic obstruction.

5. **Pressure** on the gut from without may be caused by inflammatory thickening and subsequent contraction in the neighbourhood of the bowel gradually producing a narrowing of the lumen of the tube. Thus in cases of pelvic cellulitis, in appendicitis, or in peri-nephritic inflammation, the gut may gradually be occluded and symptoms of chronic intestinal obstruction set up. The gut may also be pressed upon by malignant or other growths, as hydatid or ovarian tumours, or by a displaced uterus, and this may give rise to chronic obstruction.

6. **Chronic intussusception.**—In chronic intussusception the obstruction is not as a rule complete at first, but in many cases it becomes so after a time and proves fatal. The strangulation of the gut is not usually sufficient to cause gangrene, and therefore, as there is neither complete occlusion nor complete strangulation, this condition may last for months before death ensues; this takes place from complete occlusion coming on, or from exhaustion, or from perforation of the gut above.

Symptoms of chronic obstruction.—In chronic intestinal obstruction, constipation is the prominent symptom. The patient gets an attack of constipation, with colicky pains, and perhaps vomiting. This is relieved by medicine, and may or may not be succeeded by a mucous diarrhœa, from catarrhal enteritis set up by the irritation of the retained fæces. This is followed, after a longer or shorter period of time, by a second and a third attack, each being more obstinate than the last, more difficult to overcome, and attended by severer symptoms. Between the attacks the patient may feel fairly well, or, on the other hand, he may suffer from nausea, malaise, and loss of appetite. These symptoms persist and increase, it may be, for several months, until at last an attack occurs in which the symptoms cannot be relieved, and complete obstruction sets in. In other instances the early symptoms are not so marked. The patient may be going about his ordinary occupations, and perhaps, after the ingestion of a hearty meal of some indigestible food, complete obstruction sets in somewhat suddenly. There may be comparatively little disturbance at first, but the abdomen becomes distended, and then nausea and discomfort are experienced, followed after a time by eructations, retching, and vomiting, which may in the final stage be fæcal. Vomiting, however, is not such a marked feature as in acute obstruction. As the abdomen becomes distended, coils of intestine are visible through the abdominal wall when it is thin, and can sometimes be seen in motion. In the later stages the pain becomes more continuous and severe, and the vomiting persistent, and the patient dies, worn out with pain, vomiting, and inability to take food, and poisoned by absorption of the noxious matter from the decomposing contents of his intestinal canal. In some cases, death is hastened by the giving way of the gut above the seat of obstruction. Chronic obstruction is a disease rather of adult life than of childhood.

The symptoms are usually very obscure in the early stages, the onset being gradual, and the course varying considerably in different cases. When the obstruction is due to malignant disease, a tumour can sometimes be felt before much distension has supervened, but later on this is not possible. When it arises from fæcal accumulation, a tumour can usually be felt. It is generally movable, firm, and doughy, and the fingers can be indented in it, though in other cases it is harder and firmer, and no impress can be made on it; it is then somewhat nodulated. A point in the diagnosis between a tumour due to malignant disease and fæcal accumulation is that the latter is usually tender on manipulation, probably from the accompanying inflammation, or it may be from the presence of a stercoral ulcer; whereas in malignant disease there is no pain on pressure.

When the obstruction is due to a tumour growing from the wall of the gut, the weight of the tumour often produces invagination, and a condition of chronic intussusception is set up. The patient complains of a paroxysmal pain of a colicky character, but it is not very severe. The pain may be accompanied by vomiting, or vomiting may be entirely absent. When present, it is increased by food, and consists merely of the rejection of the contents of the stomach. If food is withheld, the vomiting, in most cases, ceases; at all events, it is rarely stercoraceous. The bowels are irregular; sometimes there is constipation; more often there is diarrhœa, with passage of blood-stained mucus, accompanied by tenesmus. There is usually not much distension of the abdomen, and on examination it is found to be flaccid and free from tenderness. A tumour can in many cases be felt through the abdominal wall, or by examination per anum. The attack may at last culminate in complete obstruction, or the patient may die of exhaustion and wasting before this comes on; or the case may be brought to a fatal termination from peritonitis, from perforation of the gut above the obstruction. Sloughing of the intussusceptum is almost unknown in chronic intussusception.

Treatment of chronic obstruction.—The treatment of chronic obstruction must vary according to the seat of the obstruction and to its cause.

When the obstruction is in the large intestine, and is due, as it most frequently is, to a malignant or cicatricial stricture, colotomy is usually indicated. Of course the ideal operation would be to perform laparotomy, excise the strictured portion of gut, and do an end-to-end anastomosis: but this is hardly practicable in a case of complete obstruction, where it has existed for a long period of time, and the bowel above is distended with enormous quantities of decomposing fæcal matter, and the patient half poisoned by absorption of noxious material from this decomposing mass. It is wiser, therefore, in most cases, to establish an artificial anus, and leave the more radical operation for a future period, when the patient will be in a better condition for its performance. When the stricture is in the most common position, in the upper part of the rectum or the sigmoid flexure of the colon, inguinal or lumbar colotomy may be performed;[1] but when it is situated higher up, the ascending colon must be opened.

When the obstruction is due to fæcal accumulation, the rectum will usually be found, upon examination, to be blocked with masses of indurated fæces. These must be removed mechanically by the surgeon, and a convenient instrument for the purpose will be found to be a large lithotomy scoop, and afterwards large oily enemata administered. At the same time, the patient should be carefully dieted, and massage and electricity to the abdomen are frequently of use.

In those cases where the cause of the obstruction is outside the gut and is due to inflammatory adhesions, nothing can be done in the earlier stages except attention to diet, mild laxatives and enemata, and later on, when complete obstruction occurs, the performance of colotomy.

When the obstruction is in the small intestine, the treatment in the earlier stages must consist in giving a diet of the simplest possible kind: the administration of mild purgatives, of which perhaps small doses of castor oil or small quantities of calomel combined with belladonna are the best, and washing out the lower bowel with copious enemata. Later on, when operative interference is called for, a laparotomy must be performed, the gut opened above the point of obstruction, and a glass tube inserted and fixed, so that the bowel may empty itself. After the more urgent symptoms have subsided, the question of enterectomy and removal of the cause of the obstruction may be entertained. If the patient's condition is serious, so that the administration of an anæsthetic and a protracted operation is contra-indicated, the proceeding described on page 850 may be adopted. In chronic intussusception, any attempt to reduce the invagination by inflation of air or injection of fluid will probably fail. The only treatment available is to open the abdomen and reduce the intussusception, by manipulation if possible. Owing, however, to adhesions, this as a rule cannot be done, and the mass must then be excised.

Idiopathic dilatation of the colon.—In connection with the subject of chronic obstruction must be mentioned a condition to which the term *idiopathic dilatation of the colon* has been given, in which the colon, and especially the lower part of it, becomes enormously dilated, so much so that the distension mechanically interferes with the respiratory and circulatory systems. It is accompanied by obstinate constipation, and as a result, with vomiting, hiccough, and other signs of chronic obstruction. These cases frequently occur in young children, and Mr. Treves believes that there is strong evidence to support the idea that they are due to congenital defects in the lower end of the bowel; others, on the other hand, believe that it may occur in children as the result of extreme and persistent constipation, aggravated by injudicious treatment.

The **treatment** must consist in the first instance in a course of massage and electric stimulation of the gut, with the administration of strychnia combined with saline aperients, and failing this, operative interference by the formation of an artificial anus. In one case Mr. Treves removed the whole of the bowel below the splenic flexure of the colon, together with the anus. The operation was followed by complete relief.

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[1] These operations will be described in the next chapter.

APPENDICITIS

The word **appendicitis** is the term commonly applied to a class of cases which was formerly known under the name of typhlitis or perityphlitis. It is now, however, very universally admitted that though true typhlitis or inflammation of the cæcum may occur, in the majority of cases the inflammation originates in the appendix, and therefore the word *appendicitis* is employed to designate this condition. There are one or two points in connection with the anatomy of the appendix to which it is desirable to refer, as they have an important bearing on the etiology and pathology of this disease. (1) The appendix, with the cæcum, is completely invested with peritoneum, and therefore any inflammation of it rapidly involves its peritoneal covering, and moreover it cannot be reached in the natural condition without opening the peritoneal cavity. (2) It is, at all events in the male, supplied by a single artery, which runs through its mesentery to it. In the female it is occasionally supplied also by a branch from the right ovarian artery. (3) It has an abundant supply of lymphoid tissue in its wall. (4) Its position varies. Most usually it is directed upwards and inwards behind the cæcum, but at other times it is directed upwards and outwards towards the kidney, or downwards towards the pelvis; or, finally, it may be herniated into the sub-cæcal or ileo-cæcal peritoneal pouches lying behind the cæcum.

Etiology.—The causes which may give rise to appendicitis are several. (1) It may be set up as a result of congestion from interference with its circulation. When the cæcum becomes distended with gas or fæcal matter, it causes dragging on the mesentery of the appendix, which is usually so short that the tube is curved on itself and cannot be straightened out. This tension interferes with the circulation through the single vessel which runs in the mesentery to supply the appendix, and produces congestion and tumefaction, and so alters the condition of the coats of the tube that the bacillus coli communis, which has no power of evil in contact with healthy mucous membrane, acquires pathological properties, and an infective inflammation is set up. (2) Appendicitis may be caused by the presence of some extraneous substance in the tube, rarely a foreign body, such as an orange pip, a bead, or cherry stone, which has been swallowed; more frequently a fæcal concretion which has become lodged in it. (3) Typhoid ulcers are occasionally found in the appendix, and may lead to appendicitis and perforation. (4) Rheumatism, tubercle, and actinomycosis are also given as causes of this affection.

Pathology.—The inflammation probably commences in the lymphoid tissue of the mucous membrane, and this accounts for the frequency of the disease in the young, in whom this tissue is most abundant. Into this structure the bacteria find an entrance either through the swollen and softened mucous coat or through some abrasion from the impaction of a foreign body, and speedily the inflammation spreads to the other coats, and the muscular, fibrous, and peritoneal coats become involved and infiltrated with inflammatory deposit. The inflammation may stop here, and the result may be merely a glueing of the appendix to neighbouring parts by adhesions. In other cases the inflammation goes on to suppuration; the pus, however, may be limited by adhesions forming between the coils of intestine and other structures around, and a circumscribed abscess may result which, although intra-peritoneal, is still shut off from the general peritoneal cavity. Again, in other instances, the inflammation, being an infective one, tends to spread and to continue; the mucous membrane of the appendix becomes ulcerated, interstitial suppuration takes place within its walls, and sloughing or perforation follow, leading to a diffuse septic peritonitis which in the majority of cases proves fatal. In the milder forms of the disease, after recovery has apparently taken place, some thickening of the tube may remain and cause a narrowing of it, so that the mucus secreted by it cannot escape, but becomes collected in the cæcal end of the tube and gives rise to attacks of intermittent pain and the persistence of a hard swelling in the right iliac fossa. This condition is sometimes known as *chronic* appendicitis.

Symptoms.—Many cases of appendicitis begin with an acute attack of pain, of a crampy, colicky character, which is usually at first referred to the umbilicus. It may last some hours, and is often attended by vomiting and shock. The symptoms are the result of the severe inflammation in the resisting and inelastic walls of the appendix, producing an intense impression on the abdominal nerve plexuses. After a lapse of time the pain becomes altered in character and in locality, and a fixed pain is complained of in the right iliac fossa, and on examination marked tenderness will be found in this situation. In other cases the advent of the symptoms is quite different: a feeling of abdominal discomfort sets in, accompanied by nausea and vomiting and usually constipation, though there may be diarrhœa. This may be regarded as a bilious attack, until somewhat suddenly the patient is seized with pain in the right iliac fossa. This pain is in a definite spot, at the junction of the outer third with the inner two-thirds of a line drawn from the anterior superior process of the ilium to the umbilicus (McBurney's spot), and is accompanied by distinct tenderness in this situation. Upon examination, a hard lump may be felt, if the patient is not very fat; this may be no bigger than the thumb, or may be as big as the fist. In some cases, upon examination by the rectum, or the vagina in the female, a swelling can also be felt. In some instances, instead of a definite hard tumour, a diffused swelling may be felt in the right iliac region, caused by coils of intestine becoming matted together around the inflamed appendix. The temperature varies; it is generally raised to about 101° to 102° F., but in some cases it is scarcely above normal, so that it does not constitute an important sign.

In the mild cases (catarrhal appendicitis) no further symptoms appear. Under appropriate treatment, in three or four days the pain subsides, the symptoms clear up, and the patient recovers.

When suppuration is about to take place, the symptoms do not subside. There may possibly be a rigor, and the temperature mounts to 103° or 104° F., the skin is hot, and the tongue furred. There is generally constipation, and frequently vomiting. The hard lump, if one has been detected, disappears, and is replaced by a diffuse tense swelling, which occupies the whole of the iliac fossa and is exquisitely tender. After matter has formed, it may gradually reach the surface; the skin becomes red and œdematous, and at last fluctuation is perceptible; or in rarer cases it may travel backwards and point in the loin, or may extend behind and above the liver, forming one variety of subphrenic abscess; or, finally, it may pass downwards into the pelvis and point by the side of the rectum. The course which the abscess takes appears in a great measure to be due to the position of the appendix. In a certain number of cases, the matter, after its formation, may burst into the bowel, when there is a sudden relief to the symptoms, the pain subsides, the swelling disappears, the temperature falls, and a quantity of pus is discharged per anum. Finally, the circumscribed abscess may suddenly become diffused and burst into the general peritoneal cavity, and diffuse peritonitis result.

Diffuse septic peritonitis may be set up in these cases either by the bursting of a circumscribed intra-peritoneal abscess, with the symptoms above mentioned, or by perforation of the appendix, when the symptoms of peritonitis may be present from the commencement.

The symptoms in these cases very much resemble those of acute intestinal obstruction. There is severe colicky pain; early, copious, and persistent vomiting, and more or less absolute constipation. The abdomen becomes distended and tympanitic, and the abdominal wall hard and rigid and tender all over, but with marked tenderness in the right iliac region, and probably dullness in this situation. The patient becomes collapsed, with great depression of strength and the ordinary general signs of peritonitis (page 809).

It has been stated above that in the simpler forms of appendicitis the tendency is to recovery, but in a large number of these cases the recovery is not permanent, and the patient is liable to get a second and third attack. He apparently perfectly recovers, there is no pain and no swelling to be felt; but after a time, it may be months or years, there is another attack of exactly the same character as the first. These cases are known as *relapsing* appendicitis.

Treatment.—In the milder forms of appendicitis, where the temperature is not high, the treatment consists in absolute and perfect rest: the patient must be kept in bed, on his back, with his thighs flexed and supported by a pillow. The part may be smeared with belladonna and glycerine, and hot fomentations applied; the lower bowel should be emptied by a large enema, and no food, except small quantities of beef tea and milk, should be given. If the pain is very severe, opium and belladonna may be administered internally; but they are better avoided, as they tend to mask the symptoms. In a large number of cases this will be all that is necessary; the pain will subside, and the case go on to recovery. If it does not, and the symptoms persist and the temperature rises, the question of operative interference will have to be considered. The greatest difference of opinion exists as to the propriety of operating under these circumstances. On the one hand, it is an undoubted fact that a considerable number of cases clear up, even where there is evidence of grave local mischief, without any operation; but there is, on the other hand, the danger of the peritonitis becoming diffuse, or of the patient becoming exhausted and profoundly toxæmic, so that the operation undertaken at a later period of the case might result in disaster. My own opinion is that it is wiser, under these circumstances, not to decide too hurriedly upon performing an operation, but rather to wait a few days, unless the pulse rate shows a tendency to increase. This is always an indication of the necessity for operation, and a rule has been laid down by Meyer that a pulse of over 120 after the first twenty-four hours calls for removal of the appendix. When the increasing pulse rate is accompanied by continuous vomiting, rigidity of the abdominal muscles, and tympanitis, the case has assumed a very grave aspect. When there is no accelerated pulse and these other symptoms are not present, we must be guided by circumstances as to whether we shall operate or not. The continuance of the symptoms and the increase in the temperature may be very probably due to the disease taking on the suppurative form; and under these circumstances, by waiting a day or two, there is less danger of soiling the general peritoneal cavity, since adhesions will have formed in the tissues around the inflamed appendix, and have thus shut off and localised the focus of suppuration. By adopting this plan also we avoid performing the operation unnecessarily; for in these cases, if the routine practice is followed of removing the appendix in the early stages of the disease, many patients must be subjected to operation who would have assuredly recovered without.

Where there is reason to believe, from the persistence of a high temperature and swelling, that an abscess has formed, it should be cut down upon and the pus evacuated. No attempt, as a rule, should be made at the time to find the appendix. It may be that after the abscess has been opened and the pus evacuated, the appendix will be found lying free in the abscess cavity; under these circumstances it may be ligatured and cut off, but any attempt to search for the appendix would inevitably be attended with the breaking down of the barrier of adhesions, and a general soiling of the peritoneal cavity. An incision is made over the point of greatest pain and tenderness, and the abdominal wall deliberately cut through until the pus is reached. When the abscess has been opened and the pus evacuated, the cavity must be gently flushed out and a drainage tube inserted. In a considerable number of cases, the abscess cavity will fill up, the wound will heal, and there will be no further trouble. But should it not do so, and a sinus be left, it will be necessary at a future date to open the abdomen and endeavour to find and remove the appendix, which can now be done with much greater safety to the patient, as instead of a large suppurating cavity there is simply a narrow track which can easily be avoided, and all risk of contaminating the peritoneal cavity prevented.

In those cases of appendicitis in which diffuse peritonitis is present, either from perforation of the appendix or from bursting of a circumscribed abscess into the peritoneum, the only hope of saving life is by performing immediate laparotomy. This operation is called for, not only for the purpose of removing a damaged appendix, but still more urgently in order to evacuate the fluid and inflammatory products which are loaded with septic organisms. The abdomen should be flushed out with some weak antiseptic fluid at a temperature of 105° F., the appendix sought for and removed, and efficient drainage provided. In spite of all this the majority of cases die, but in some few instances the patient may recover.

In **chronic appendicitis**, where the patient has recovered up to a certain point, but still has some pain and tenderness at one particular spot—McBurney's spot—and a small swelling can be felt in this situation, there ought to be no delay in cutting down and removing the appendix. Such cases may explode and become serious at any moment.

Finally, in cases of **relapsing appendicitis**, especially if the attacks are at all frequent, removal of the appendix is indicated; at any time the patient may get an attack of appendicitis, which will put his life in far greater peril than he will incur by submitting to the operation.

Operation for removal of the appendix.—In the cadaver the operation of removing the appendix is as simple as possible; but in patients who have suffered from repeated attacks of appendicitis the parts may have become so matted together and altered in position that the operation is by no means easy, and there may be the greatest difficulty in even finding the appendix. Several different incisions are recommended for opening the abdomen. Some surgeons recommend an oblique incision, through McBurney's spot and parallel with Poupart's ligament; others make the incision parallel to the right semilunar line, but external to it, and when the internal oblique and transversalis muscles are reached, separate the fibres of these muscles, which run in the reverse direction to the external incision. By this means they hope to prevent the occurrence of a ventral hernia, which sometimes follows the operation from yielding of the cicatrix. Personally, I prefer an incision in the right semilunar line, and this is the one I have always adopted.[1] When the peritoneum is reached, it must be opened with caution, for coils of intestine may be adherent to its under surface. The first object to be sought for is the cæcum, which will be recognised by the longitudinal bands of muscular fibres. The anterior band should be traced downwards, and will be found to lead to the appendix, which will probably be bound down by adhesions, and these will have to be separated or broken down. When found, sponges are to be carefully packed all round it, and the appendix entirely freed, if necessary with a few touches of the scalpel. The mesentery of the appendix is transfixed and tied in one or two parts with fine silk, and then divided with scissors up to the cæcum. At about three-quarters of an inch from the cæcum the serous and muscular coats of the appendix are divided by a circular sweep with a sharp knife, leaving the mucous coat undivided. The two outer coats are then stripped back towards the cæcum with a director, and the tube of mucous membrane tied close to the bowel with a catgut ligature, and cut through. The outer coats are then turned in over the stump, and the serous surfaces stitched together, so as to sequestrate the end of the tube. After the appendix has been removed, the cavity is washed out, a drainage tube inserted for twenty-four or forty-eight hours, and the rest of the wound closed. In some cases the tissues are so infiltrated and matted together that this proceeding is not possible; I have then found that the best plan is to tie the vermiform appendix close to the cæcum, cut it off, and then sequestrate the stump by burying it in the cæcum and bringing the serous coat on either side into apposition by two or three Lembert's sutures.

HERNIA

The word **hernia** in its widest sense means the protrusion of any viscus from its natural cavity, but when used alone it is far more commonly intended to apply to the protrusion of one of the abdominal viscera through the parietes of the abdomen; when employed to denote the protrusion of other viscera, it is supplemented by the name of the viscus which protrudes; thus we speak of hernia of the brain, of the lung, or of the testis. Furthermore, it is implied that the protruded viscus is covered by integument; we do not speak of a perforating wound of the abdomen, in which a portion of gut protrudes, as a hernia.

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[1] Battle recommends the following procedure in order to avoid a subsequent ventral hernia. He divides the superficial structures an inch internal to the right semilunar line, and opens the sheath of the rectus. He then separates the rectus from the posterior layer of the sheath with his finger, and retracts it inwards and divides the posterior layer of the sheath and peritoneum in the same line as the external incision. After the appendix is removed, he sutures the posterior layer of the rectus and peritoneum with one row of sutures; then allows the rectus muscle to return to its natural position, and sutures the anterior layer of the sheath and the superficial structures with separate rows of stitches.

A hernia consists of three essential parts: (1) sac; (2) contents; and (3) coverings. 1. The **sac** is composed of peritoneum, and may not in all cases be quite perfect. It is of two kinds: (*a*) congenital, and (*b*) acquired. (*a*) The *congenital* form arises from some defect in the process of development, where a diverticulum of the peritoneum, which exists naturally in the fœtal state, and which should be closed at birth, remains open, and into this the hernia descends. Such conditions are seen where the funicular process of the tunica vaginalis does not become closed, and the hernia descends into the sac of the testis; or in the female, where the canal of Nuck remains patent and the hernia descends into it. The hernia which is formed under these conditions is known as a congenital hernia, but it must be distinctly understood that the sac may exist without any hernia, and that when a hernia does occur it may be years after birth, even in adult life, but still it is a congenital hernia. (*b*) The *acquired* form is where the sac is developed out of the normal peritoneum. It arises from some weakness in the abdominal wall, especially in those situations where the abdominal wall is more or less deficient in order to allow structures to pass through; as in the inguinal region, where the inguinal canal exists for the passage of the spermatic cord, or in the femoral region, where the femoral ring exists for the passage of the femoral vessels. The pressure of the viscera gradually forces the peritoneum covering this weak spot through it, as the viscus itself protrudes, so that sac and contents are protruded together. When it has emerged from the cavity of the abdomen, it swells out into a pyriform tumour and consists of a dilated sac, which is called the *fundus* or *body*, and a constricted part, the *neck*, by which it communicates with the general peritoneal cavity. At first there is nothing perceptible but a little fullness, with an abnormal impulse on coughing when the patient is in the erect position; this immediately disappears when he lies down. Thus, taking an inguinal hernia as an illustration, a little bulging appears at the position of the internal abdominal ring. This is accompanied by pain and a sensation of weakness. After a time a distinct somewhat sausage-shaped swelling appears in the inguinal region, which, however, at once disappears upon the patient assuming the recumbent position. Still later the swelling, gradually increasing, finds its way through the external abdominal ring and then speedily reaches the bottom of the scrotum. In the congenital form this gradual process of development is not observed; as soon as the hernia protrudes through the internal ring, it finds its way to the bottom of the scrotum. In the majority of cases the sac wall does not become much altered; it increases partly by dragging down fresh material, mainly from the peritoneum covering the iliac fossa, which is loosely connected to subjacent structures, but principally after its first formation by extension of its own walls. The interior of the sac is smooth and glistening, and resembles normal peritoneum; the outer surface is rough and marked by arborescent vessels. When first formed the sac can be easily pushed back into the peritoneal cavity, but it early tends to form adhesions to the structures outside the abdomen, with which it has come in contact, and then its reduction is impossible. When under these circumstances we 'reduce a hernia,' we push back the contents of the sac, but leave the sac behind. When this adherent sac is exposed to pressure, from an ill-fitting truss for example, inflammation may be set up in it, and it may become much thickened and form a dense, fibroid membrane. The neck of the sac is usually more or less rounded, and the peritoneum is here often thrown into folds, so as to present a plicated appearance. In a few instances the sac may not be complete. In hernia of the cæcum, for instance, in those rare cases where the viscus is not completely surrounded by peritoneum and has therefore no mesentery, this portion of intestine may find its way outside the abdomen, and under these circumstances would not be completely invested by peritoneum, and therefore necessarily the serous envelope would be incomplete.

2. The **contents.**—It has been said that a hernial sac may contain any of the abdominal viscera with the exception of the pancreas : the spleen, the gall bladder, and possibly a part of the liver; the kidney, the ovary frequently; and the bladder have all been found in a hernial sac. Almost any part of the intestinal canal may be found in the sac; the most common is the ileum, then the jejunum; of the large intestine the cæcum is most commonly herniated; sometimes it may be only the vermiform appendix, but the transverse colon and the sigmoid flexure are also rarely found in a hernial sac. Of all structures the omentum and the ileum are the ones most commonly found in a hernial sac. When the omentum is found alone, the word *epiplocele* is applied to the hernia; when intestine alone is present, it is called *enterocele*; and when the two are present in the same sac, the term *entero-epiplocele* is employed.

Loose foreign bodies are sometimes found in hernial sacs. They are believed to be appendices epiploicæ which have become detached, and consist of a central core of fatty material encased in a fibrinous envelope. They are rounded, smooth, and generally single.

Hydrocele of a hernial sac.—A collection of fluid may sometimes be found in a hernial sac, which cannot be returned into the abdomen. This may be caused in two different ways. (1) The neck of the sac may become obliterated, and all communication with the peritoneal cavity shut off; fluid then collects in the sac. This is very rare. (2) A portion of the sac may be shut off by adhesions, generally adhesions of the omentum to the wall of the sac, and thus a cavity is formed in which fluid collects. This subject will again be referred to in connection with hydrocele.

3. The **coverings.**—The coverings of the hernia usually tend to become thinned as the rupture increases, and the various layers which anatomically form the covering become more or less fused together, so that it is impossible to distinguish or differentiate them from one another. The pressure of an ill-fitting truss may, however, cause a certain amount of inflammatory exudation, and as a consequence thickening and induration of the tissues covering the sac.

Anatomical varieties of hernia.—The most common situation for a hernia is one which protrudes through the internal ring into the inguinal canal, and which may or may not protrude through the external abdominal ring. This is an inguinal hernia, and is computed to include 84 per cent. of all cases. The next most frequent form is the femoral hernia, which descends through the femoral ring. This includes about 10 per cent. The third common form is the umbilical, which protrudes at or near the umbilicus. In addition to these usual varieties, hernia may also protrude through other parts of the abdominal wall, through the obturator foramen, sciatic notch, diaphragm, or into the vagina. Ventral hernia is that form where the protrusion takes place through some spot in the abdominal wall which has been weakened by injury or disease.

Etiology.—In speaking of the etiology of hernia, we must refer to the predisposing and exciting causes.

1. **Predisposing causes.**—(*a*) *Age.* Hernia is exceedingly common in

young male infants, and this arises from two causes: first, because the funicular process may not be closed, and thus a congenital hernia may be produced; and secondly, because a congenital phimosis may exist, and the constant straining to pass water may cause the protrusion of the gut. Except in infants, herniæ do not frequently make their appearance for the first time till about the age of fourteen or sixteen, when on account of structural alterations attending puberty and more active exercise and employment, hernia becomes more common and continues to increase in frequency during the whole of the active period of life up to about fifty. After this, especially in women, hernia becomes less frequent. (*b*) *Sex.* Hernia is very much more common in men than in women. It has been estimated that four or five men suffer from hernia to one woman. This no doubt is to be accounted for to a certain extent by the more active employments in which men are engaged, but still more to the large size and greater patency of the inguinal canal in males, which renders inguinal hernia exceedingly common in males, whereas in females after puberty it is not common, and after the age of forty is very rare. In female children the inguinal is the common form of rupture in the groin, femoral being almost unknown. (*c*) *Heredity* does not appear to be a very potent agent in the production of hernia, though, according to Mr. Macready, it ought to be recognised as one of the predisposing causes. (*d*) *Structural defects.* Considerable attention has been bestowed upon the length of the mesentery as one of the predisposing causes of hernia. It has been found that after death in a healthy adult the mesentery is not sufficiently long to allow of a piece of small intestine being dragged through the inguinal canal or the femoral ring; it has therefore been supposed that there must be some elongation of this structure which acts as a predisposing cause; but at present all that can be said is that this is merely a supposition, and that nothing can be definitely stated on the subject. Mr. Lockwood believes that the point of attachment of the mesentery to the bodies of the vertebræ may become shifted lower down, and that this 'prolapse' of the mesentery may be a predisposing cause of hernia. Other structural defects which may predispose to hernia are deficiencies of development, such as those already alluded to as giving rise to congenital hernia; namely, a patent or partially patent funicular process of the tunica vaginalis or a patent canal of Nuck, and in addition to these a deficiency at the umbilicus, giving rise to congenital umbilical hernia. (*e*) *A relaxed condition of the abdominal muscles*, occurring after severe illness, accompanied by rapid wasting, or after pregnancy, may be a predisposing cause of hernia, as also may be any injury which weakens one particular spot of the abdominal wall, such as wounds, ruptured muscle, or abscess. (*f*) *Occupation* must be ranked among the predisposing causes of hernia. All occupations involving severe muscular exertion, especially if undertaken in a stooping position, as lifting heavy weights, are likely to produce a hernia, and this is especially probable if the workman, as is so frequently the case, wears a tight belt or band round his belly. (*g*) Finally, it must be stated that hernia is more common on the right side of the body. This is accounted for in several ways: by the greater amount of exertion to which the right side of the body is subjected in right-handed people; from the presence of the large glandular organ, the liver, on the right side, and from the inclination of the mesentery to the right iliac fossa.

2. **Exciting causes.**—The exciting cause of hernia is anything which compresses the abdominal contents, so as to squeeze them out of the

abdominal cavity through some weak spot, and this is especially likely to occur if the compressing force is suddenly applied and is intermittent. Thus all violent muscular efforts may determine its occurrence, such as lifting a heavy weight, straining at stool, or severe fits of coughing. It may also be produced by the prolonged efforts of straining induced by stricture, enlarged prostate, or phimosis, in attempting to pass water.

Clinical varieties of a hernia.—A hernia may present itself, at different times, in several different phases or clinical aspects. It may be (1) reducible, that is to say, returnable into the abdominal cavity; (2) irreducible, when it cannot be returned into the abdomen; (3) obstructed, when the lumen of the intestinal tube is blocked, so that the contents cannot pass onwards; (4) inflamed, where there is acute or sub-acute inflammation of the hernial sac or its contents; and (5) strangulated, when the circulation through the herniated portion of bowel is arrested.

1. **Reducible hernia.**—This is when the hernia, or at all events the contents of the sac, can be pushed back into the abdominal cavity, or returns of itself when the patient lies down. It is the most common clinical variety of hernia, and, with a few exceptions, the form in which hernia presents itself in its early stage.

Symptoms.—The patient complains of a swelling, usually in some situation where a hernia is known to occur, accompanied by pain, and sensation of weakness in the abdomen above the swelling. The pain varies in amount, is usually of a gnawing, dragging character, and is increased by exertion. Accompanying this there are often symptoms of dyspepsia, nausea, and irregularity of the bowels. The tumour is rounded or pyriform in shape, broader below than above, and a narrowed neck can be traced upwards to one of the abdominal openings. It varies somewhat as to whether it contains intestine or omentum. When it contains intestine it is smooth, regular, and elastic, and becomes tenser when the patient strains. If the gut contains flatus, it is tympanitic on percussion: if it contains fluid matter or is empty, the percussion note is dull. When the patient coughs there is a distinct impulse, and this impulse is of a distensile nature, similar to the impulse which is conveyed to the fingers in an aneurism; that is to say, if the fingers are made to grasp the swelling, there will be felt to be a dilatation in every direction, so that the fingers become more widely separated from each other. When the patient is lying down and pressure is applied for the purpose of reducing the hernia, the intestine first glides smoothly out of the sac and then disappears suddenly. If there should chance to be any fluid in the intestine, this reduction is accompanied by a very characteristic gurgle. If after reduction the patient is made to stand up and the hernia allowed to return, the swelling will be seen to appear from above and descend into the sac. This is a very important sign, and serves to differentiate a hernia from a fluid swelling which can be returned into the abdomen, and in which there may be an impulse on coughing. The fluid swelling increases from below upwards, as the fluid collects in the sac. Lastly, a hernial tumour is opaque to transmitted light; at all events, under most circumstances. In a large scrotal hernia in an infant, in which there is nothing but intestine in the sac, a certain amount of translucency may be perceived. When the hernial sac contains omentum, the tumour is flabby, uneven, and inelastic: it is always dull on percussion; there is an impulse, except when the hernia is small, but it is much less marked than the distinct and expansile impulse which is felt when gut is present. There is, of course, no gurgle. When an omental hernia is reduced it returns slowly, and not in the sudden manner in which the bowel returns.

The **treatment of reducible hernia.**—A reducible hernia may be treated by (1) the application of trusses, or (2) by the radical cure—that is, operation.

1. **Treatment by trusses.**—A truss is a surgical instrument which is applied for the purpose of keeping the hernia reduced in whatever position the body is placed, and must therefore be regarded in a great measure as palliative treatment; but nevertheless it is an undoubted fact that a certain percentage of cases are cured by wearing a truss for a number of years. This is especially true of hernia in young children, where the application of a truss for two or three years is often followed by a cure. It is also true to a certain extent in young adults, in whom there is a fair chance of cure by a truss up to about the age of thirty. After this age there is very little prospect of a cure being effected.

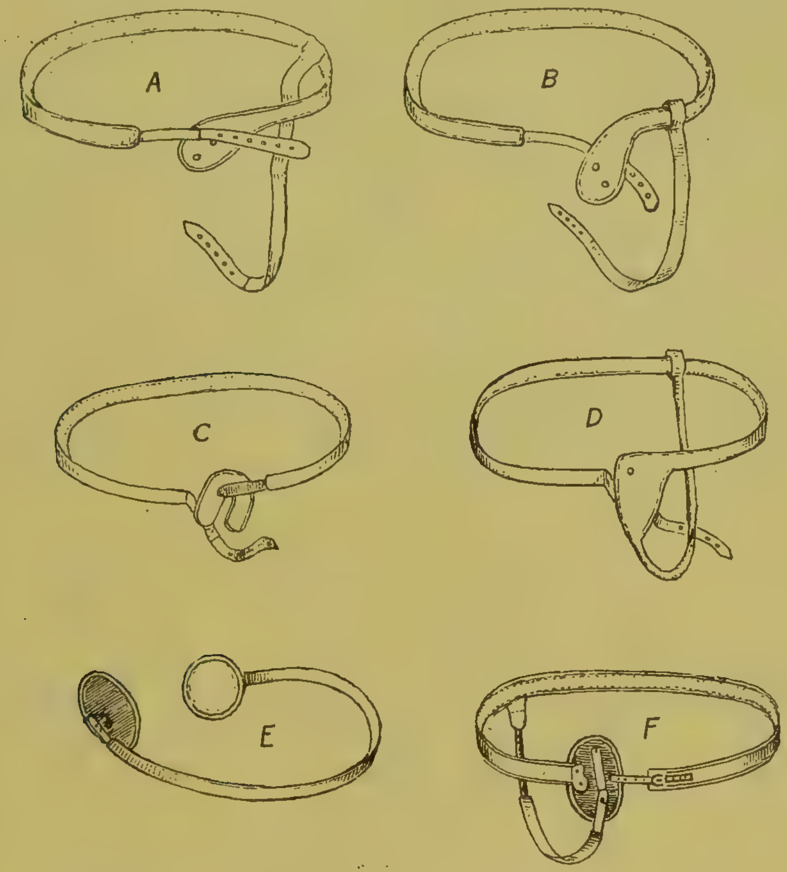

FIG. 338.—Various forms of truss. A, ordinary spring truss for inguinal hernia; B, ordinary spring truss for femoral hernia; C, Wood's inguinal truss with horse-shoe pad; D, rat-tailed truss; E, Salmon and Ody's truss; F, Moc-main truss.

A truss consists of a pad, which is placed over the orifice through which the hernia protrudes, and a spring which maintains the pad in position. The different forms of truss which are recommended are very numerous, and it would be impossible in this work to allude to them all, and probably it will be sufficient if we indicate the essentials of a good truss, and mention two or three of the principal varieties. A truss should be light, firm, elastic, and should fit accurately, so that it maintains its position in whatever attitude the body is placed.

In the ordinary spring truss, which is the form most commonly used, the pad is usually composed of a piece of soft metal lined with cork and covered by wash leather; but other materials, such as india-rubber, vulcanite, ivory, or cushions filled with air or water, are sometimes used. The shape of the pad must vary according to the variety of the hernia and its size. In the inguinal hernia the pad should be pyriform in shape, so as to press on the whole length of the inguinal canal (fig. 338, A); in some cases, where the hernia is of considerable size, of old standing, with a large external abdominal ring and therefore difficult to retain, the pad should be triangular; this is known as the rat-tailed or semi-tailed truss (fig. 338, D). Wood recommended that in inguinal hernia the pad should be made of box-wood and should be horse-shoe in shape, so as to support the pillars of the ring and the inguinal canal without pressing on the spermatic cord (fig. 338, C). In femoral hernia the pad is made much smaller than in inguinal hernia, so that it may not obstruct the femoral vein; it is also made more convex, so as to press more directly on the femoral ring and canal. Its relation to the spring is much more oblique than in the inguinal truss, for whereas in the latter the pad is a direct continuation of the spring, in the femoral truss it is turned downwards and forms an angle with it. (Compare A and B, fig. 338.)

The spring consists of a steel band, possessed of considerable elasticity, which encircles the body (in the case of a single truss) from just behind the anterior superior spinous process on the sound side to the pad (fig. 339). As it passes round the back it lies across the base of the sacrum, and on either side it should rest about midway between the crest of the ilium and the upper level of the great trochanter. As it turns round just below the anterior superior spine to reach the abdomen, it presents a bend which is known as the *shoulder*. It should fit evenly and comfortably, just in contact with the skin, but without pressing upon it at any part. From the extremity of the spring on the sound side a thong of soft leather is carried round to the front of the abdomen and fixed by a button to the upper part of the pad. In addition to this a second softly padded band is fixed to the spring, in the inguinal truss, a little behind the anterior superior spine on the affected side, and in a femoral truss a little in front, and is brought underneath the 'fork' and fixed to a button on the lower and

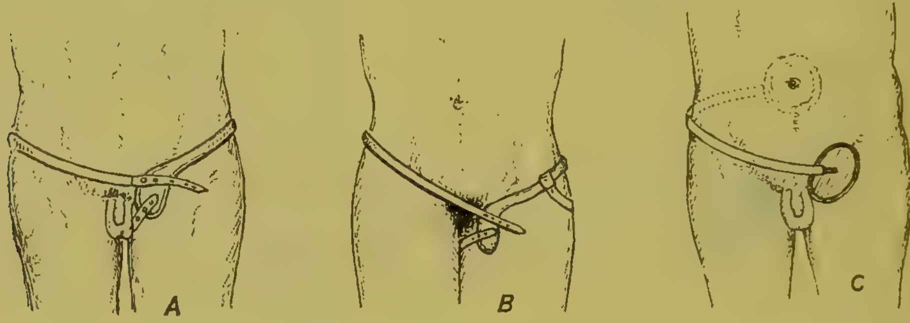

FIG. 339.—Mode of applying the truss. A, inguinal; B, femoral; C, Salmon and Ody's. In all the hernia is on the left side.

inner part of the pad. The object of this second belt is to keep the pad in position and prevent it riding upwards during the movements of the body. When there is a double rupture, that is to say, a hernia on either side, the spring is made to almost completely encircle the body, and terminates at either extremity in a pad. In the case of inguinal rupture, the two pads are connected by a cross strap passing from one to the other and fixed by buttons on to the pads.

Some modifications of the ordinary spring truss may be briefly alluded to. Salmon and Ody's truss consists of a semicircular spring, having fixed to its posterior extremity a flat, circular plate, which rests against the upper part of the sacrum. In front the pad is fixed to the spring by a ball-and-socket joint, so as to allow movement of the spring on the pad in any direction. The truss is self-retaining, and does not require any straps to hold it in position. The spring, however, is made to encircle the opposite side of the body to that on which the hernia is situated, and therefore is rather more than a semicircle and crosses the pubes (fig. 339, C). This truss possesses some advantages; it is exceedingly strong and reliable, and is adapted for labouring men, porters, navvies, &c., who are engaged in laborious occupations and especially in lifting heavy weights. But it is irksome to wear, and is particularly uncomfortable while the patient is lying in bed. Coles's truss is somewhat similar. It consists of a semicircular spring fixed to a pad behind, but the spring is applied to the affected side, and attached to the plate behind is a soft belt which encircles the sound side and is attached to the pad in front by a button. The pad over the hernia has a spiral spring inside, instead of being made of some solid material.

The moc-main truss is constructed on quite a different principle. There is no steel spring around the body, but in its place a softly padded belt. The pad is of large size, and attached to its external surface is a spring and lever (fig. 338, F). To the end of the lever is attached a perineal band, fixed to the back of the belt. By tightening this band the lever causes the pad to make pressure over the site of the hernia, so that the pressure can be regulated by the degree of tension of the band. This truss is said to be comfortable, but it is not so reliable as the other forms. It is especially applicable for a small hernia in the debilitated or aged, who are not engaged in any severe manual labour.

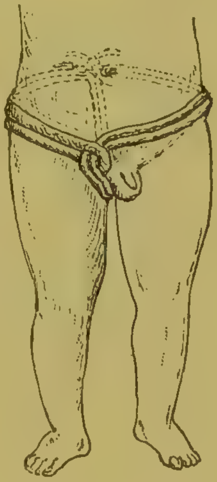
FIG. 340.—Mode of applying the skein of wool truss.

In infants and very young children a truss is not easily adapted, and moreover is inconvenient because it is liable to become soiled by the fæces and urine. When a truss is employed in these cases, it must be covered with some impermeable material. An excellent substitute for a truss is afforded by a skein of wool. This is applied in the following way: it is placed round the body in such a manner that the loop at one end of the skein is over the opening in the abdomen through which the hernia descends; the other end is then carried through the loop and under the perineum, and fixed behind to the portion of the skein encircling the body (fig. 340). This can be changed as often as necessary. In the treatment of hernia in male children, circumcision should be performed if there is any phimosis.

Trusses should be worn both night and day, but a very much lighter one is all that is necessary for night wear, and the patient should be provided with one of this sort, which he should be enjoined to change after he has retired to bed, or at all events in the recumbent position. He should also be provided with a second day truss in case anything goes wrong with the one he is wearing; and, finally, he requires a bathing truss —a truss covered with some impermeable substance, which he can wear while taking his morning bath.

In order to measure for a truss the patient should be in the recumbent position. The end of the measuring tape should be placed over the spot which the pad is to occupy and carried round the body, midway between the crest of the ilium and the great trochanter, and across the back of the sacrum to the point from which it started. This measurement, together with the variety of hernia and the side, is all the information which the instrument maker requires. It is generally advisable, however, to mention whether the abdomen is very prominent or not.

To ascertain whether the truss fits, attention must be paid to the spring and the pad. The spring should everywhere be in contact with the skin, without pressing upon it, and the patient should be able to move his body in any direction without shifting its position. The pad should be larger than the aperture through which the hernia protrudes, and should not be too convex, so that its summit presses on the ring. In an inguinal hernia the pad should press mainly upon the internal ring, and the pressure should be upwards with an inclination backwards and outwards. In a femoral hernia the pad should not be large enough to press on the femoral vein. The pressure should be made almost directly upwards, as the pad rests on the saphenous opening.

2. **Treatment by operation.**—The subject of the radical cure of hernia is one which has attracted very considerable interest of late years, and there is very great difference of opinion as to the cases in which this operation should be performed, and as to the best method of performing it.

Indications for the operation.—As long as a hernia is small, it can be always retained by a truss; and if the patient is not exposed to any violent exertion, the risks of such a rupture are slight, the prognosis favourable, and no operation is called for, and if one is performed it should only be done at the request of the patient, to free him from the irksomeness of wearing a truss, from the slight risk which he runs of strangulation, and in order to render him physically sound.

There are certain cases in which there can be no question as to the advisability of an operation. Among these are cases where no truss seems adequate to keep the rupture up. This is most frequently so with inguinal herniæ of moderate size, but with a large ring, in which no instrument can be adjusted which will retain the rupture in position, at all events without causing great distress to the patient. These are cases which require operation. Then again there are cases where the patient is desirous of entering one of the public services, to which he is ineligible if he is the subject of hernia. In such cases there can be no doubt as to the propriety of operating. The radical cure is also called for in most cases of irreducible hernia, and after the operation of herniotomy. These cases will be considered in the sequel; at present we are simply dealing with reducible hernia.

In addition to these cases there are many others in which the question of performing a radical cure will have to be considered, and there are several points which will have to be taken into consideration: (1) The occupation; (2) the age; (3) the social position; (4) the general health; and (5) the temperament of the patient.

1. **As regards the occupation.**—If a man is engaged in sedentary occupations, there is little chance of his rupture coming down with a well-fitting truss, whereas if the subject is a labouring man exposed to injury and strain, there is always the chance that the hernia may descend, even though a fairly efficient truss is applied. The radical cure is therefore more indicated in these latter cases than the former.

2. **The age.**—In the elderly patient there is little necessity for advocating a radical cure, because he is not likely to engage in any laborious occupation, and moreover it is not desirable to perform it, for he is not a favourable subject for the operation; but in the younger man who is full of vigour and activity, it is desirable to render him as physically sound as possible. In quite young children, there is considerable difference of opinion as to whether it is right to operate or not. The reasons which have been given why it is undesirable to operate on young children, are on account of the difficulty in maintaining the wound aseptic; and secondly, because a permanent cure may be effected by wearing a truss. The first objection is not a very valid one—with care and good nursing there ought to be no great amount of difficulty in keeping the wound aseptic; but with regard to the second, though it is true that in a certain percentage of cases a hernia may be cured by wearing a truss, still it must be remembered that this can only be accomplished if the mother or nurse is intelligent and willing to devote herself to managing the truss, and this, especially among the poor, is not easy to accomplish. The truss is liable, particularly in fat children, to shift during the movements of the child; it is also liable to become soiled by the urine and fæces, and to become a source of irritation; and again, in consequence of the growth of the child, it speedily becomes too small and requires renewing. Finally, it would appear in many cases, where a cure by truss is supposed to have taken place, that this is not so, especially in cases of congenital hernia, but that there is merely a narrowing of the funicular process, which prevents the rupture coming down for a time, but that later on in life the hernia recurs. On all these grounds, a radical cure in children is to be advised.

3. The **social position** of the patient has to be taken into consideration. We have seen that to be fully equipped a patient with a rupture requires four trusses, and these are constantly getting out of order and require renewal, and therefore the treatment of hernia by trusses is a source of considerable expense, which to a poor man is burdensome and is an extra reason for advising him to submit to operation.

4. The **general health** of the patient should always be taken into consideration, and the existence of any organic disease of the viscera is an indication for the non-performance of the operation.

5. The **temperament** of the individual should also be taken into account. In some the constant wearing of a truss is exceedingly irksome and repugnant, whereas others do not seem to mind it in the least. Where the former is the case, it would be an extra inducement to advocate operative interference.

Many different plans of operation have been introduced of late years, more particularly in the treatment of inguinal hernia, for which the radical cure is especially applicable. We shall first of all consider the operation for the cure of this form of hernia; and secondly, the radical cure in femoral and umbilical hernia. It will be impossible to do more than briefly allude to the different modes of operating, and to describe in full the plan which I usually adopt as being the one which in my hands has given the most satisfactory results.

Until about eighteen years ago there were practically two ways of operating for the radical cure of hernia—Wützer's and Wood's—and neither of these plans is now employed. Wützer's method consisted in forcing a boxwood plug into the inguinal canal and fixing it there. Wood's plan consisted in invaginating the dartos of the scrotum into the inguinal canal, and attaching it there with an ingenious but complicated subcutaneous suture. In the year 1880, Spanton, of Hanley, introduced a new method of operation. He freed the sac through an incision, and by means of a needle shaped like a corkscrew pierced the sac and the walls of the inguinal canal in many places, thus bringing them together and narrowing the calibre of the canal. The needle was left in position from a week to a fortnight. About the same time Annandale and others suggested a plan which has been largely adopted and variously modified. It consists in exposing the sac and freeing it from surrounding structures ; the neck is then ligatured and the sac removed, and the pillars of the external abdominal ring sewn together, sufficient room being left for the passage of the cord at its lowest part. Some of the various modifications of this operation are as follows : Mitchell Banks employs strong silver wire to close the ring, which remains there permanently, and in some cases includes the conjoined tendon with the inner pillar. Stokes, of Dublin, opens the neck of the sac, and then inserts carbolised sutures through the opened neck and through the tissues close to the abdominal ring. He then closes the ring with silver wire. Ball, of Dublin, after isolating the sac, twists it into a cord, so as more effectually to close the portion of the sac contained in the canal, and then ties it with a catgut suture. Hardie, of Manchester, advocates passing the ligature not only around the neck of the sac, but around the infundibuliform fascia as well. In these operations the sac is removed ; but many surgeons prefer to retain the sac and deal with it in different ways. Macewen invaginates the sac (which he has plaited into a number of folds by a piece of silk passed through it several times) into the canal, and fixes it to the abdominal ring ; he then closes the inguinal canal by suturing the conjoined tendon to Poupart's ligament. Kocher isolates the sac up to the internal abdominal ring ; he then makes an opening through the abdominal muscles above and external to the ring, and through this opening the detached sac is drawn ; it is then twisted into a cord, and fixed by sutures in front of the canal. Treves performs a somewhat similar operation, but removes part of the sac, twists the remainder into a cord, and passing it beneath the conjoined tendon, brings it out through an opening near the middle line and fixes it with sutures. He then closes the canal. In both these operations the main object is to alter the direction of the neck of the sac and bring it out through a new opening. Stanmore Bishop turns the sac inside out, invaginates it, and fixes it across the internal orifice of the inguinal canal in such a manner that the wrinkling up of the sac produces a 'boss exactly over the internal ring.' W. H. Bennett performs a similar operation, but fixes his boss away from the ring. Many other proceedings, too numerous to mention, have also been practised by different surgeons ; but a more radical measure than any appears to be the plan recommended by Bassini, or a somewhat similar operation by Halstead, and which consists in making a new inguinal canal.

Bassini's operation.—The parts having been previously shaved and purified, an incision is made about five inches in length, parallel to and a short distance above Poupart's ligament. The subcutaneous tissues are incised, and the aponeurosis of the external oblique exposed; this is then divided on a director, so as to open up the whole length of the inguinal canal. The sac as it lies in the canal is to be carefully separated from the spermatic cord and surrounding structures, up to the internal abdominal ring. The spermatic cord is drawn out of the way by an assistant, and if there are any varicose spermatic veins they should be ligatured and removed. The sac is now opened, its contents reduced, and it is then cut off close to the internal abdominal ring, and the gap thus left in the peritoneum closed by sutures. The lower part of the sac in the scrotum may now be isolated from surrounding structures, and the whole of it removed; or, what is better, the tubular portion of it which lay in the inguinal canal may be removed, and the lower part sewn up and allowed to remain in the scrotum. The canal is now completely closed by suturing the arched fibres of the internal oblique and transversalis, and the outer border of the conjoined tendon, to the deep aspect of Poupart's ligament, by a continuous buried suture; the outermost stitch closely embracing the cord as it passes out through the internal abdominal ring. The spermatic cord is now replaced, and the divided edges of the aponeurosis of the external oblique and the pillars of the ring sutured over it, leaving a small opening at its internal extremity, through which the cord emerges. The incision in the skin is then united. Halstead's operation is somewhat similar, but differs in two essential particulars. One is that the fibres of the internal oblique at the outer margin of the internal ring are divided, and the cord displaced outwards along this incision, and there fixed; and the other is that the cord is brought outside the external oblique muscle and lies immediately beneath the skin. No particular advantage appears to be gained by this method; in fact, some have thought that the direct opening into the abdominal cavity which is produced in Halstead's operation is more likely to conduce to recurrence than the oblique opening of Bassini, which certainly has this merit—that it imitates nature.

There is nothing special in the after treatment of these cases, except that the patient should be kept in the recumbent position for at least a month after the operation, although the wound has in all probability healed, and should only undertake light work for some weeks after he gets about. Under these circumstances a truss is not, in the majority of cases, required nor desirable. In some few cases where the patient's muscular system is weak, and the abdominal muscles therefore presumably in the same condition, it may be desirable to wear a light truss for a time.

Radical cure of femoral hernia.—The radical cure of a femoral hernia is not so frequently called for, nor is it so successful as in inguinal hernia. Three methods have been adopted. (1) The sac is exposed, isolated, ligatured as high up as possible, and then cut away. In some cases this is all that is done; in others, an attempt is made to partially close the femoral ring by passing a suture through Poupart's ligament near the spine of the os pubis, and through the fascia covering the pectineus muscle, and tying the two ends together; but this is not very efficient, because if any serious attempt is made to approximate the parts, the femoral vein becomes compressed. (2) Watson Cheyne recommends that a flap of the pectineus should be dissected up and transplanted into the femoral canal, where it is fixed by sutures, so as to close it and prevent the descent of the hernia. (3) Treves recommends that the sac should be isolated, the lower part cut away, and the upper part twisted into a cord and ligatured. This cord is then carried through an incision made in Poupart's ligament close to the pubic spine, and fixed in this position.

Radical cure of umbilical hernia.—This is nothing more than the ordinary procedure of sewing up an abdominal wound: the sac is divided close to the opening, and the cut edges of peritoneum sutured together; the margins of the ring are then in their turn brought together by a buried suture, and the skin united in the ordinary way.

The operation for the radical cure of a reducible hernia is not a dangerous one, but it must be borne in mind that it sometimes fails in attaining the end in view, and is followed by a recurrence. Often, however, where the proceeding fails to cure the hernia, some improvement is obtained by the operation, especially when the operation is undertaken for a large scrotal rupture, which no truss seems competent to retain. In these cases, it will generally be found, if the hernia is not radically cured by the operation, that a truss can be applied which will fulfil the purpose for which it was intended. The main objection to Bassini's and Halstead's operation is that this would not appear to be so; if the condition recurs after operation, it partakes more of the character of a ventral hernia, and as such is very difficult to retain.

2. **Irreducible hernia.**—An irreducible hernia is where the contents of the sac cannot be replaced into the abdominal cavity; in all other respects it resembles an ordinary reducible hernia; that is to say, the passage of the contents of the intestine are in no way impeded in those cases where there is gut in the sac, nor is the circulation of blood through it in any way interfered with. It therefore gives rise to no symptoms of obstruction or strangulation, although it may cause flatulence and dyspepsia.

Causes.—The chief causes of the irreducibility of a hernia are: (*a*) some altered condition of the contents of the sac. It may be the presence of adhesions, either between the sac and its contents, or between the contents themselves. Adhesion of the omentum to the sac wall very frequently takes place, and this is one reason why omental herniæ are so often irreducible; the intestine is not nearly so liable to become adherent to the sac wall. In other cases, inflammation may occur in the omentum, and it may become converted into a solid mass, which cannot be unravelled and cannot therefore be reduced. (*b*) The large size of the hernia may prevent its reduction. Where a large scrotal hernia has been down for years, the abdominal cavity becomes contracted, and therefore there is no room for the displaced gut. (*c*) A large deposit of fat may take place in an epiplocele, and may prevent its reduction. (*d*) The neck of a herniated omentum, when it passes through the ring, may become atrophied by the constant pressure of the encircling band, and the fat may entirely disappear from this part; this renders the omentum irreducible. Occasionally, however, the irreducibility may depend upon changes in the sac itself: the neck may become narrowed and unduly thickened, or bands of adhesion may stretch across the sac and may prevent the reduction of any gut or omentum which may be present in the sac.

Symptoms.—The symptoms referable to the hernia itself are the same as those of reducible hernia, except that the rupture cannot be returned: there is the presence of a pyriform swelling, with an impulse on coughing, and the other physical signs enumerated above. And in some cases there is no additional trouble, but usually the condition is accompanied by flatulency and colic, dragging pain in the part, constipation, and symptoms of dyspepsia. If untreated, irreducible herniæ have a tendency to increase in size; they are apt to become obstructed where the gut is involved, or inflamed and even strangulated. They are also much exposed to injury, and a blow on the part may at any time place the patient's life in imminent danger.

Treatment.—There are three plans of treating irreducible hernia. (*a*) By confining the patient to bed, on a low diet, so as to reduce his fat; by raising the foot of the bed, and maintaining pressure over the hernia by a pad and bandage or a bag of shot. This, with the occasional application of taxis, may succeed in reducing the hernia when it is a recent one, for it must be remembered that irreducibility is very often a transitory condition. (*b*) By means of some artificial support or truss, which must vary according to the nature and size of the hernia. In *complete inguinal* hernia, the best form of instrument is the *hinged truss cup*. This consists of an ordinary inguinal truss, to the pad of which a hollow cup is fixed by a transverse hinge. This cup is made of soft metal, lined with wash-leather, and is accurately moulded to the scrotal swelling. To its free border perineal straps are attached, and by tightening these the cup makes firm pressure on the scrotum, without communicating any pressure to the pad, as this is prevented by the hinge. In the *incomplete inguinal* hernia and in the *femoral* hernia, if small, a hollow pad attached to the ordinary spring is applied. The hollow pad should accurately fit the hernia, and in order that this may be accomplished, a plaster cast should be taken and the pad moulded on this. In *umbilical* hernia, in the same way the hernia should be supported by a hollow metal cup moulded to it, and this is to be kept in position by an elastic abdominal belt. It is stated that in a certain percentage of cases reduction of the hernia may be effected after a considerable time by wearing one of these appliances. (*c*) By operation. In the majority of cases of irreducible hernia, the best plan of treatment is to open the sac, remove any omentum which may be present, reduce the intestine, and perform a radical cure. There are several reasons why this course is the best: the hernia probably produces distress from pain and dyspepsia; it is liable at any time to become obstructed, inflamed, or strangulated, and it is always exposed to injury. In those cases where the intestine is so intimately adherent to the sac that it cannot be separated, the adherent portion may be cut off from the rest of the sac and reduced with the intestine. Where the hernia is of very large size and has been irreducible for many years, no operation should be performed. If such is attempted, it will usually be found that it will be impossible to reduce the gut, and serious results have followed the endeavour. In these cases the only treatment is to support the hernia by an elastic bag or a hinged truss cup.

3. **Obstructed or incarcerated hernia.**—An obstructed or incarcerated hernia is where the bowel has become obstructed by fæcal matter or undigested food, and in which therefore the passage of the contents of the intestine down the tube is arrested. It is almost always met with in herniæ of the large intestine, which are irreducible, and most commonly occurs in umbilical herniæ, though large scrotal herniæ also sometimes become obstructed.

The **symptoms** are those of intestinal obstruction, and usually come on gradually and run a chronic or subacute course. The tumour is noticed to be larger than natural, and to be painful and tender to the touch. It is dull on percussion, and presents a doughy, boggy sensation to the fingers. It can, for the most part, be diminished in size by pressure, but it is nevertheless quite irreducible. It presents an impulse on coughing, which is not, however, so distinct and marked as the impulse of a reducible hernia. The patient complains of colicky pains over the abdomen, and soon begins to vomit, but merely rejects the contents of the stomach, and if food is withheld the vomiting ceases, at all events in the earlier stages; the tongue becomes furred, the abdomen distended, and there is constipation, but the constipation is not absolute; flatus, and perhaps even a certain amount of fæcal matter, may be passed. In the later stages, especially in the aged, collapse may supervene. The symptoms may persist for several days, and then pass off when the bowels are relieved, or they may gradually pass on into symptoms of strangulation.

To a certain extent the symptoms of obstruction resemble those of strangulation, and the one condition may be mistaken for the other; but the diagnosis may be made by observing the non-persistence of the vomiting if food is withheld, the absence of complete obstruction, and by noting the presence of an impulse on coughing.

Treatment.—The patient should be confined to bed, and an ice bag applied to the part. A little morphia or opium should be given to relieve pain and promote sleep, and no food, except an occasional spoonful of milk and water, for twenty-four hours. Then a copious oil enema should be administered, followed, after the lower bowel has been emptied, by a full dose of castor oil. After the bowels have been relieved, the patient should be kept in bed until all local pain has subsided, and a careful system of dieting must be enjoined to prevent another attack.

4. **Inflamed hernia.**—A hernia usually becomes inflamed as the result of some injury to an irreducible hernia, either a blow on the part, or too violent or too prolonged taxis, or from injury produced by an ill-fitting truss. It is essentially a form of localised peritonitis involving the sac and its contents. The inflamed parts, if examined, are found to be red and injected, and covered over with flakes of lymph; there is usually a little fluid in the sac, and the effused lymph becomes organised and forms adhesions between the sac and its contents. In some cases there may be considerable effusion, and this may go on to suppuration.

Symptoms.—The swelling becomes hot, tender, and painful; it is tense and firm, and the pain is increased by pressure. There is an impulse on coughing. With these local signs are associated fever, vomiting, and constipation. This condition, therefore, like the obstructed hernia, resembles to a certain extent strangulation; but the vomiting is merely the rejection of the contents of the stomach, and is never stercoraceous, and the constipation is not complete. Moreover, in these cases there is fever, with an elevated temperature, in contradistinction to the collapse which speedily supervenes when the bowel is strangulated.

Treatment.—The patient should be kept absolutely at rest in bed, with the parts in as relaxed a position as possible; on low diet, consisting simply of fluid; hot fomentations, or hot Goulard lotion with opium, should be applied to the part, and a little opium given internally to relieve pain. The condition usually subsides in a few days, but may terminate in general peritonitis. If suppuration should take place, an incision must be made and the pus evacuated.

5. **Strangulated hernia.**—A hernia is said to be strangulated when it is constricted in such a way that there is an obstacle to the free

circulation of blood through the herniated portion of gut or omentum, or whatever the contents of the sac may be. An obstacle to the passage of the intestinal contents is not a necessity, since a portion only of the lumen of the gut may be involved (Richter's hernia), but nevertheless is usually present, and the hernia is at the same time irreducible. Omentum may be strangulated—that is, may have the circulation through it interfered with when it is herniated—just as much as intestine, but it is infinitely less common. We shall consider first the strangulation of a knuckle of intestine. When a portion of intestine is forced through a narrow aperture for the first time, as in a congenital hernia, the unyielding margins of the ring may press upon the blood-vessels in such a way as to retard the circulation through them, and produce a condition of venous congestion in the herniated portion of bowel; or when, in a hernia which has existed for some time, an additional amount has been extruded from any cause acting from within, as coughing, sneezing, and vomiting, the same thing is brought about, the bowel becomes constricted so that the venous circulation is interfered with, and strangulation is the result. When once the bowels have been thus constricted, all further changes which take place are due to the interference with the circulation. The vessels, especially the veins, are constricted, and the portion of bowel which is herniated becomes turgid with black blood, since the blood which still finds its way in cannot find its way out; and so the part becomes swollen and black, and the difficulty in reduction is increased. Finally, the circulation in the arteries comes to a standstill, and the lack of supply of fresh blood imperils the life of the portion of bowel which is involved. Unless relieved, the condition speedily ends in gangrene.

The constricting agent in most cases is either the neck of the sac itself, or it may be the ring of tissues outside the sac, as, for example, Gimbernat's ligament in femoral hernia; but in rare cases it may be due to adhesions in the sac, under which a coil of intestine becomes strangulated, or to a twisting of a loop of intestine in a hernial sac. Strangulation most commonly follows the protrusion of an unusual amount of intestine, which is forced through the hernial orifice by pressure acting from within the abdominal cavity; it is often due, therefore, to some sudden exertion, or to some violent expulsive effort. But this is not always the case, for a hernia has been known to become strangulated during sleep; so that increased peristalsis from some intestinal irritation, or increased swelling in the contents of the sac, may produce such a condition as will interfere with the circulation and produce strangulation.

When a portion of intestine becomes strangulated, it is first purple and then black; its walls are thickened from exudation taking place from the loaded vessels, and its surface loses its natural shiny appearance from shedding of its epithelium. Occasionally some of the loaded vessels give way, and spots of ecchymosis appear on the surface. Flakes of lymph may now appear upon it, and it becomes dull and sticky. So far, however, it is in a perfectly recoverable condition, and if the cause of the strangulation is removed it speedily recovers its natural appearance. But if the strangulation is continued, it becomes ashy grey in colour, usually in spots, and loses its elasticity, it is soft and doughy, and falls into a condition of gangrene, which may affect the whole or only a part of the strangulated loop. The sac may be unaltered or it may be inflamed, and eventually gangrenous, owing to the action of the bacilli coli communis which have found their way through the damaged gut into the sac. A certain amount of fluid is usually found in the sac. In the early stage this is generally a clear serous fluid, or it may be blood-stained from the giving way of engorged vessels in the congested gut. Later on, it becomes brownish and turbid, and may be even purulent. It is often very offensive, having a distinct fæcal odour, even although the gut is not perforated. The tissues outside the sac are in the early stage unaffected, unless they have been bruised by forcible taxis, but later on they become swollen and œdematous, and after a time gangrenous. They then give way, and in this manner a natural cure may be effected with the formation of an artificial anus.

When a portion of bowel has been strangulated, and the cause of the strangulation is removed, it will be found that the bowel at the seat of stricture presents a white ring where it has been nipped. Here the bowel is perfectly anæmic; and ulceration, followed by perforation, may take place at this part, the ulceration commencing on the mucous surface and gradually extending through the muscular to the serous coat.

When omentum is strangulated it becomes engorged, and of a dark red or purplish colour, and eventually black. In some cases it may become actually gangrenous, when it is ashy grey, soft, and pultaceous; if, however, it has contracted adhesions to the sac wall, it may receive sufficient nutritive supply through these to maintain its vitality.

Symptoms.—The first symptom of strangulated hernia is severe pain at the site of protrusion, most usually occurring during some laborious effort or severe straining, and accompanied by a sudden swelling, if the hernia is congenital and has never appeared before; or by the forcing down of the rupture larger than it has been before, if a reducible hernia already exists. In cases where there is an irreducible hernia it becomes harder and fuller. This sudden descent is usually attended with shock; the patient becomes cold and faint, and breaks out into a cold sweat; there is a feeling of nausea, and perhaps actual vomiting. This shock is not very prolonged, but the pain increases in severity and radiates over the abdomen. The sensation of sickness increases, and the patient vomits, first the contents of his stomach, then bile-stained fluid, which after a time becomes brown and offensive and finally stercoraceous. The bowels may act once, but as a rule there is absolute constipation from the first, and the patient passes neither flatus nor fæces. The abdomen becomes tense, tender, and tympanitic. There is great constitutional depression, and the patient is speedily exhausted, so that in a few hours the strong vigorous man is utterly prostrate. The pulse is rapid and feeble; the temperature falls; the face is pinched and the eyes sunken, and the expression is one of intense anxiety. There is great thirst, and the tongue is dry and brown. Locally, the tumour, if a hernia has existed already, is larger than usual. It is tense and hard, and extremely tender and painful. It is absolutely irreducible, dull on percussion, and without any impulse on coughing.

The advent of gangrene is usually marked by a cessation of pain and by an increase in the collapse. The patient gets hiccough, and the surface of his body becomes covered with a cold sweat. The vomiting continues, and the vomit comes up in gushes. He lies in bed restless and utterly prostrated, and dies of toxæmia, due to the absorption of poisonous products from the putrefying contents of his intestinal canal, or from exhaustion and acute septic peritonitis. The tumour, when gangrene has supervened, becomes softer and the tension in it diminished. The skin over it is dusky red, and emphysema may be present in the subcutaneous tissue. If the patient survives, the skin becomes black, gives way, and the fæces are discharged through the opening. In this way, in rare instances, a patient may survive a strangulated hernia.

Strangulated omental hernia.—An epiplocele may become strangulated, and may produce symptoms which cannot be distinguished from strangulated gut, though this is denied by some, who say that you do not get any symptoms if a piece of omentum is tied, and therefore there is no reason to suppose that you should get them when a piece of omentum is strangled by a band. They account for the symptoms which are undoubtedly set up in several ways; to a small knuckle of intestine being strangulated as well as the omentum, or to obstruction due to dragging on the colon, or to peritonitis. The two conditions are, however, not the same. When a portion of omentum is tied by a ligature, it is tied so tightly that it is at once killed; whereas a piece of strangulated omentum in a hernia sac is only partially strangled, and the cause of the symptoms may be the irritation of the nerves of the strangulated omentum being reflected to the intestines. In most cases of strangulated omentum the general symptoms are not nearly so severe as when the gut is strangled. The constitutional depression is not so great; the vomiting is not so urgent or persistent, and the constipation may not be so complete. The local signs are also somewhat vague; there is usually a doughy swelling, which is painful on handling, but has not the same degree of tension which is present in a strangulation of the intestine. The symptoms may persist for some time, and eventually terminate in general peritonitis; or, in consequence of the dragging on the bowel, some kinking may take place, and complete obstruction ensue.

Richter's hernia.—When a part only of the calibre of the gut is implicated the name of *Richter's hernia* is given to the condition (fig. 341). In these cases the lumen of the bowel is not completely occluded, and owing to this circumstance the symptoms are not usually quite so marked. The most frequent variety of hernia in which this condition is found is femoral hernia, though it does occur in the inguinal variety. It is nearly always the lower part of the ileum which is the portion of the bowel involved. The amount of the intestine which is strangled varies, but in the majority of cases it is less than one-half, and in these cases the obstruction is not usually complete; but if more than half the bowel is involved, the acute bend in the tube which it causes entirely prevents the passage of fæces and flatus, and there is complete obstruction. Vomiting usually sets in early in these cases, but it is not so severe nor so frequent as in the ordinary form of strangulation. It rarely becomes stercoraceous. The tumour is of small size, but is always very painful. As a rule the constriction is very tight, and therefore gangrene in these cases sets in early, and death frequently occurs from perforative peritonitis. On account of the tightness of the stricture there is also great difficulty in reducing the hernia by taxis, so that on these grounds the percentage of mortality in Richter's hernia is very high.

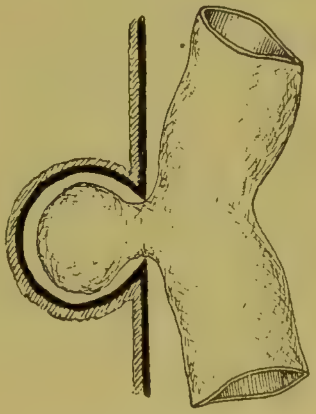
FIG. 341.—Richter's hernia. Diagrammatic.

Treatment.—The object in treating strangulated hernia is to endeavour to relieve the strangulation, and there are two measures which may be employed to bring this about: (1) taxis; (2) operation.

1. **Taxis** is the name given to the manipulations by which it is attempted to forcibly reduce the contents of the sac into the abdominal cavity. It is applied in the following way. The patient is placed on his back with the shoulders raised, and the thigh on the affected side slightly flexed so as to relax the abdominal wall. The tumour is then grasped by the fingers of the right hand and is first pulled downwards in order to extend the neck of the hernia, and is then compressed so as to, as far as possible, empty the distended vessels. The fingers of the left hand now grasp the neck of the sac, in such a manner as to steady it and form a sort of canal or funnel along which the hernia shall travel backwards into the abdomen. The right hand, which has until now been merely compressing the hernia, is employed in endeavouring to push it back into the abdomen. The direction in which this is to be done must differ with the variety of the hernia. In inguinal hernia the pressure is to be made upwards, outwards, and backwards; in femoral hernia it is to be first made downwards and backwards to force it through the saphenous opening, and when this is done backwards and upwards; in an umbilical hernia the pressure should be directly backwards. Taxis must be applied with the greatest amount of caution, and never for a longer period than ten minutes at the utmost. It must be remembered that the object on which it is applied is a knuckle of intestine, the walls of which are gorged with blood, œdematous and more or less softened, so that these are very likely to be irretrievably injured if any great force is applied. There is no question that the great mortality which followed herniotomy in former days was in a large measure due to the violent and prolonged taxis to which the patients were subjected before operation was resorted to.

Taxis should never be applied in any case (*a*) where the superficial parts show any evidence of inflammation; (*b*) where the hernia has been long strangulated; (*c*) where the symptoms are very acute; and (*d*) where the hernia was previously of the irreducible variety. The rule with regard to taxis is somewhat as follows: If a hernia is seen shortly after strangulation, taxis should be applied for five minutes if the symptoms are fairly acute, and this time may be prolonged to ten minutes if the symptoms are not urgent. Beyond this it is probably not wise nor expedient for the surgeon to persevere; and if he fail in reducing the hernia in this time, he should desist from any further attempt, and at once prepare his patient for operation. After the patient is completely under the anæsthetic, before the operation is commenced, a second short attempt may be made to reduce the hernia by taxis, and failing this the operation should at once be proceeded with. Formerly attempts were made to effect reduction by placing the patient in a hot bath to induce relaxation of the muscles; or by applying ice to the part to contract the vessels of the contents of the sac, and thus by diminishing the bulk facilitate reduction; but these measures are scarcely to be recommended, as they waste valuable time, and delay proceedings which should be undertaken as soon as possible.

Accidents incidental to taxis.—During the employment of taxis, various accidents may occur. (*a*) The entire sac, together with its contents, may be pushed into the abdomen, and if the stricture is in the neck of the sac, the strangulation will be unrelieved. This is known as reduction *en masse* or *en bloc*. (*b*) In consequence of the manipulation the neck of the sac may become torn, and the strangled loop may be forced into the sub-peritoneal tissue. (*c*) In congenital inguinal hernia there is sometimes a diverticulum or pouch coming off near the neck of the sac, and extending upwards either between the planes of muscles or between the muscles and transversalis fascia, or between the fascia and peritoneum. Into this pouch the hernia, still strangulated, may be forced by the taxis. This condition is known as reduction *en bissac.* (*d*) In some cases the reduction may not be complete. A small inguinal hernia may be forced from the scrotum into the inguinal canal and no farther, and in a fat patient this may not be detected, and it may be thought that the hernia has been completely reduced. Under all these circumstances the symptoms persist; and in case of the persistence of symptoms after the apparent reduction of a hernia by taxis, one of these conditions may be suspected if it has been noted that the reduction was effected slowly and without the characteristic slip and gurgle. Persistence of the symptoms may depend upon other causes. The bowel may have been so much damaged that it does not recover itself and may remain paralysed; or peritonitis may be set up and produce symptoms which resemble strangulation; or, finally, there may be some internal strangulation or a strangulated hernia in some other part of the body which may have given rise to the symptoms.

In the event of the persistence of the symptoms after reduction by taxis, a careful examination must be made to ascertain, if possible, the cause. In most cases it will be found the better plan to open the abdomen in the middle line, and deal with the cause in this way; but if there seems to be fairly clear evidence that the persistence of the symptoms is due to reduction *en masse* or *en bissac*, it may be sufficient to make an incision over the site of the supposed strangulation, and search for the sac; if it cannot be found, the incision may be prolonged upwards, and in this way the abdominal cavity may be explored.

2. **Herniotomy.**—Operative interference in strangulated hernia consists in performing the operation of *herniotomy* or *kelotomy*. This is essentially an operation by which the sac is exposed and opened; the stricture divided from within, and the contents of the sac returned into the abdomen. Formerly there were two methods of operating: one in which the sac was exposed but not opened, and the stricture divided from the outside; and the other where the sac was opened and the stricture divided from the inside. The former plan, which was believed to be peculiarly applicable to femoral hernia, where the stricture is usually Gimbernat's ligament, and is therefore outside the sac, has now been completely abandoned for several reasons: first, because the condition of the gut cannot be ascertained; secondly, because it is quite possible that the stricture may be inside the sac, and, by dividing the structures outside, the sac and its contents may be returned into the abdominal cavity, with the strangulation unreduced; and thirdly, because if the operation is performed without opening the sac, the fluid contained within it, and which, as we have seen, may contain the bacilli coli communis, is forced back with the bowel into the abdominal cavity.

The operation should be performed at as early a date as possible, after the diagnosis of strangulation has been made, and taxis, employed as indicated above, has failed to reduce the hernia. The patient having been prepared by shaving and the necessary cleansing, an incision is made over the tumour, and the various layers divided down to the sac; no object is attained by endeavouring to recognise and name the various layers, which should be divided one after another till the sac is reached, care being taken not to dissect them up, lest pockets be left. Any small vessels which may be wounded are seized and clamped. The sac may be recognised by the vessels being arranged in a network over it. It is to be seized with a pair of dissecting forceps, and a small nick made into it. The escape of fluid will at once indicate that it has been opened. The sac is now to be divided to the full extent of the external incision, and its contents examined. If there is apparently nothing in the sac but omentum, this must be carefully unravelled, for in some cases a small knuckle of intestine may be ensnared and be completely surrounded with omentum. The cause of the strangulation is to be sought for, and can be felt by introducing the forefinger into the sac, and carrying it to the upper part along the herniated contents, when a tight constricting band or ring will be felt, sometimes so tight that the finger nail cannot be passed underneath it. This has to be divided: the tip of the finger or a broad flat director is passed beneath it, and guided by this a hernia knife is introduced and the ring divided. The hernia knife is a blunt-pointed straight or curved bistoury, with a cutting edge of about three-quarters of an inch, commencing the eighth of an inch from the extremity. The direction in which the stricture is to be divided must depend upon the variety of the hernia. In an inguinal hernia the incision is made directly upwards, while in a femoral hernia it is made upwards and inwards. Some surgeons, instead of dividing the stricture from within, recommend that it should be divided from the outside by retracting the edges of the wound. Certainly this plan possesses the advantage that it is done under the guidance of the eye of the surgeon, and there is less risk of the intestine being wounded by its lapping over the edge of the director. It is, however, less expeditious, and with care a wound of the intestine can be avoided. After the stricture has been divided the loop of bowel should be pulled down to ascertain its condition at the point of stricture: here will generally be seen a white line (page 876). If this is whole, and there appears to be some inclination for colour to return in it, it may be safely left. The gut is now washed and returned. Any omentum, if slight in amount and unaltered, may be washed and returned; but if there is a considerable quantity, or it appears to be congested or in any way matted together, it is wiser to remove it. It should be transfixed with an aneurism needle about its centre, close to the point where it emerges from the abdomen; and a ligature having been inserted in the aneurism needle, and the needle withdrawn, the omentum is to be securely and firmly tied in two portions, and then cut off below the ligature, leaving a sufficient stump to prevent the ligature slipping.

The operation above described may have to be modified in several ways according to the state of the bowel.

1. If the bowel is in a satisfactory condition, and it is noticed that it begins to lose its black hue after the stricture is divided, it may safely be returned, even if it is covered with flakes of lymph, but under these circumstances it should be thoroughly well irrigated and cleansed with hot antiseptic fluid before it is replaced in the abdominal cavity.

2. If the condition of the bowel is doubtful, but recovery is thought to be possible, after the stricture is divided it should be well irrigated and gently replaced within the hernial orifice. It will not stray from this position, and if it subsequently gives way, adhesions will have formed, and the fæcal matter will be discharged externally. Under these circumstances the external wound should not be entirely closed, but a drain inserted down to the situation of the gut.

3. In those cases where upon examination it is found that the white ring does not recover itself after the release of the stricture, or where it is evident that all the coats have been destroyed except the serous coat, or even in some cases where there is a minute perforation, it may be possible to sequestrate this part by suturing the serous surfaces together on either side of the line by a row of Lembert's sutures; but this can only be done in those cases where the bowel around is fairly normal, and this is very seldom the case. Under other circumstances the portion of bowel involved must be excised, and the opening closed by a Czerny-Lembert suture or an end-to-end anastomosis performed.

4. When the gut is obviously gangrenous, two courses may be pursued. (1) The stricture may be left undivided, and a free incision made into the gangrenous gut; this will usually be sufficient to give a free exit to the fæcal matter, but if not a pair of dressing forceps should be introduced, and the opening gently dilated. An artificial anus is thus formed, and through this the patient is allowed to pass his fæces until he shall be in a condition to stand an operation for the radical cure of the artificial opening. The great objection to the formation of an artificial anus is that the opening may be made high up in the small intestine, so that there is not sufficient length of tube left for absorption, and the patient perishes from inanition. (2) The other plan of treatment consists in resecting the gangrenous bowel, and in uniting the resected portions by an end-to-end anastomosis; returning the sutured bowel into the abdomen and closing the external wound. There is no question that the second plan of treatment is the better of the two, if it can be carried out, but usually the patient in these cases is in a desperate condition from the prolonged or severe strangulation which must have existed before the bowel can have become gangrenous, and is not in a state to stand a severe and protracted operation. Now-a-days, when the end-to-end anastomosis can be performed with much greater celerity by the use of Murphy's button or some such appliance, this plan of treatment has become much more generally practised, and with a very fair measure of success. The decision as to which operation shall be performed must depend, therefore, upon the age and condition of the patient; if he is not in a profound condition of exhaustion, resection of the gut should be attempted.

Radical cure.—After the gut has been returned into the abdomen, in all simple and uncomplicated cases it is desirable that a radical cure should be performed by one of the methods enumerated above. The operation is already half completed by the necessary procedure to reduce the gut; and if the patient is in a condition to stand it, there can be no question that it is the duty of the surgeon to at once proceed to perform one of the various operations which has for its object an occlusion of the canal down which the hernia descends, in order to relieve the patient of his trouble.

After treatment.—The treatment of a patient after the operation of herniotomy is of considerable importance. He should be placed on his back in bed, with a pillow under his knees, so as to relax the abdominal muscles, and as a rule, unless he is very much exhausted, nothing should be given by the mouth for the first twenty-four hours, except hot water in small quantities to allay vomiting and relieve thirst. If the patient is in severe pain, which is not, however, usually the case, a hypodermic injection of morphia should be given, otherwise no form of opium should be administered, as it tends to maintain the paralysed condition of the bowel. At the end of twenty-four hours liquid food, beef tea, and milk may be given, in small quantities at first, and increased as the stomach is able to bear it. The tongue, which at the time of the operation was brown and dry, will become clean and moist, and the bowels will generally act spontaneously in the course of a few days. Should, however, this not be the case, and the tongue become covered with a white creamy fur, or sickness supervene, a large common enema should be given, followed, if necessary, by a dose of castor oil.

Fæcal fistula and artificial anus may result from strangulated hernia, and the two conditions occur under very different circumstances. The fæcal fistula is generally caused by ulceration taking place along the line of constriction of the bowel, and is the result of the destruction of a small part of the lumen of the tube, and has therefore a tendency to undergo a natural process of cure. Artificial anus, on the other hand, is caused by gangrene of the knuckle of intestine which has been herniated, and therefore involves a considerable amount of the gut, and hence spontaneous cure does not take place. These two conditions have already been discussed (page 835).

ANATOMICAL VARIETIES OF HERNIA

We have now to describe briefly the various anatomical forms of hernia, and first of inguinal hernia.

Inguinal hernia is that form of hernia in which the protrusion takes place into the inguinal canal, and if allowed to progress, through the external abdominal ring into the scrotum. It is by far the most common form of hernia, constituting about 84 per cent. of all cases. It is divided into two varieties, according to the position of the neck of the sac with regard to the deep epigastric artery. In those cases where the hernia comes down through the internal abdominal ring, and therefore the neck of the sac is external to the epigastric artery, we have what is called an *oblique* inguinal hernia. This is the more common condition of the two. In those cases where the hernia passes outwards through the triangle of Hesselbach, and directly through the external abdominal ring, the neck of the sac is necessarily internal to the epigastric artery, and these herniæ are known as *direct* inguinal herniæ.

Oblique inguinal hernia (fig. 342).—In the oblique form of inguinal hernia, the protrusion passes out of the abdomen through the internal abdominal ring into the inguinal canal. If it is arrested there, it forms an *incomplete* inguinal hernia or *bubonocele*. If, as more commonly happens, it traverses the whole length of the inguinal canal, and, emerging at the external abdominal ring, descends into the scrotum, it is known as a *complete* inguinal or *scrotal* hernia. There are numerous varieties of the oblique inguinal hernia, which may be considered under two heads: (*a*) The acquired hernia; (*b*) hernia dependent upon congenital abnormalities.

a. The **acquired hernia** is much the more common. As it passes down through the internal ring it pushes the parietal peritoneum covering the ring before it, and so forms the sac, which is protruded down the inguinal canal and through the external ring into the scrotum in front of the hernia, and thus forms one of its coverings (fig. 343, 1); as it passes through the internal ring, it acquires a covering from the infundibuliform fascia, and as it passes along the inguinal canal, a covering from the cremasteric muscle and fascia. As it passes out of the external ring it receives another covering from the aponeurosis of the external oblique, viz. the intercolumnar fascia. So that the coverings of a complete inguinal hernia are skin, subcutaneous tissue, and superficial fascia, the intercolumnar fascia, the cremasteric muscle and fascia, the infundibuliform fascia, the subserous areolar tissue, and the peritoneum.

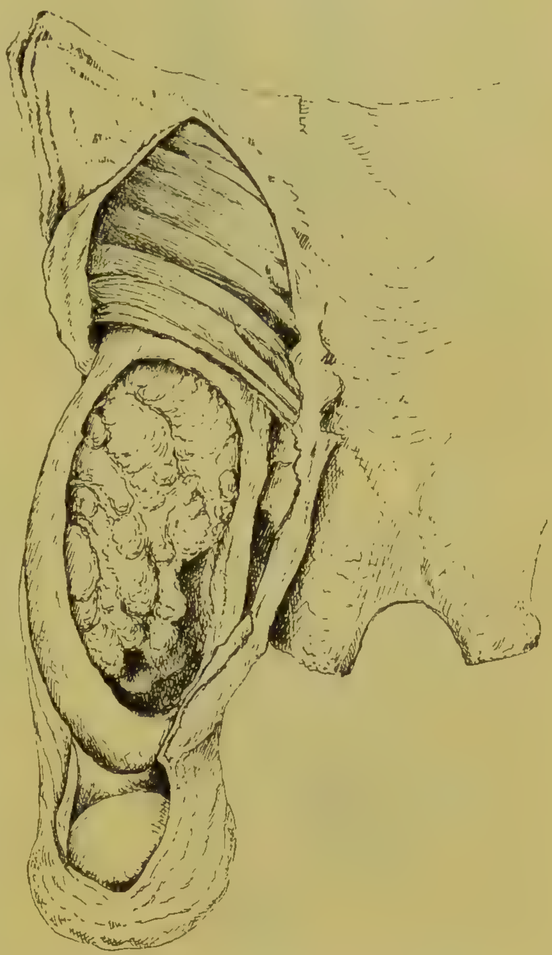

FIG. 342.—An oblique inguinal hernia. (From the Museum of St. George's Hospital.)

b. The other forms of oblique inguinal hernia are dependent on imperfect development. When the testicle descends, during fœtal life, into the scrotum, it carries a process of peritoneum with it to form the tunica vaginalis. This at first forms a cul-de-sac at the bottom of the scrotum, in which the testicle is lodged, and communicates with the general peritoneal cavity by a sort of passage or tube, the *funicular process.* During development this tube should become closed and impervious from the internal abdominal ring to the top of the testicle. It may, however, remain open throughout, or in the process of obliteration it may become occluded at one of two points, either at the internal ring or just above the epididymis, and remain pervious throughout the rest of its extent. If it remains open throughout, the hernia descends into the tunica vaginalis and comes into contact with the testicle ; this constitutes *congenital* hernia (fig. 343, II). Where the pouch of peritoneum is occluded at the internal ring, and remains patent throughout the rest of its extent, two varieties of oblique inguinal hernia may be produced, which have received the names respectively of *infantile* and *encysted* hernia. In the *infantile* variety (fig. 343, III) the hernia pressing on the peritoneum in the immediate neighbourhood of the occlusion causes it to yield and form a sac, which descends behind the tunica vaginalis, so that there are three layers of peritoneum, the two layers of the tunica vaginalis and the sac between the bowel and the surface of the body. In the *encysted* form (fig. 343, IV) the hernial protrusion pressing on the occluded spot causes the occlusion itself to yield, so that the hernia descends *into* the funicular process, and thus we have a sac within a sac, and only two layers of peritoneum separate the contents of the sac from the surface of the body.

When the funicular process becomes closed at its lower extremity only, the hernia descends into this process, as in the congenital form, but does

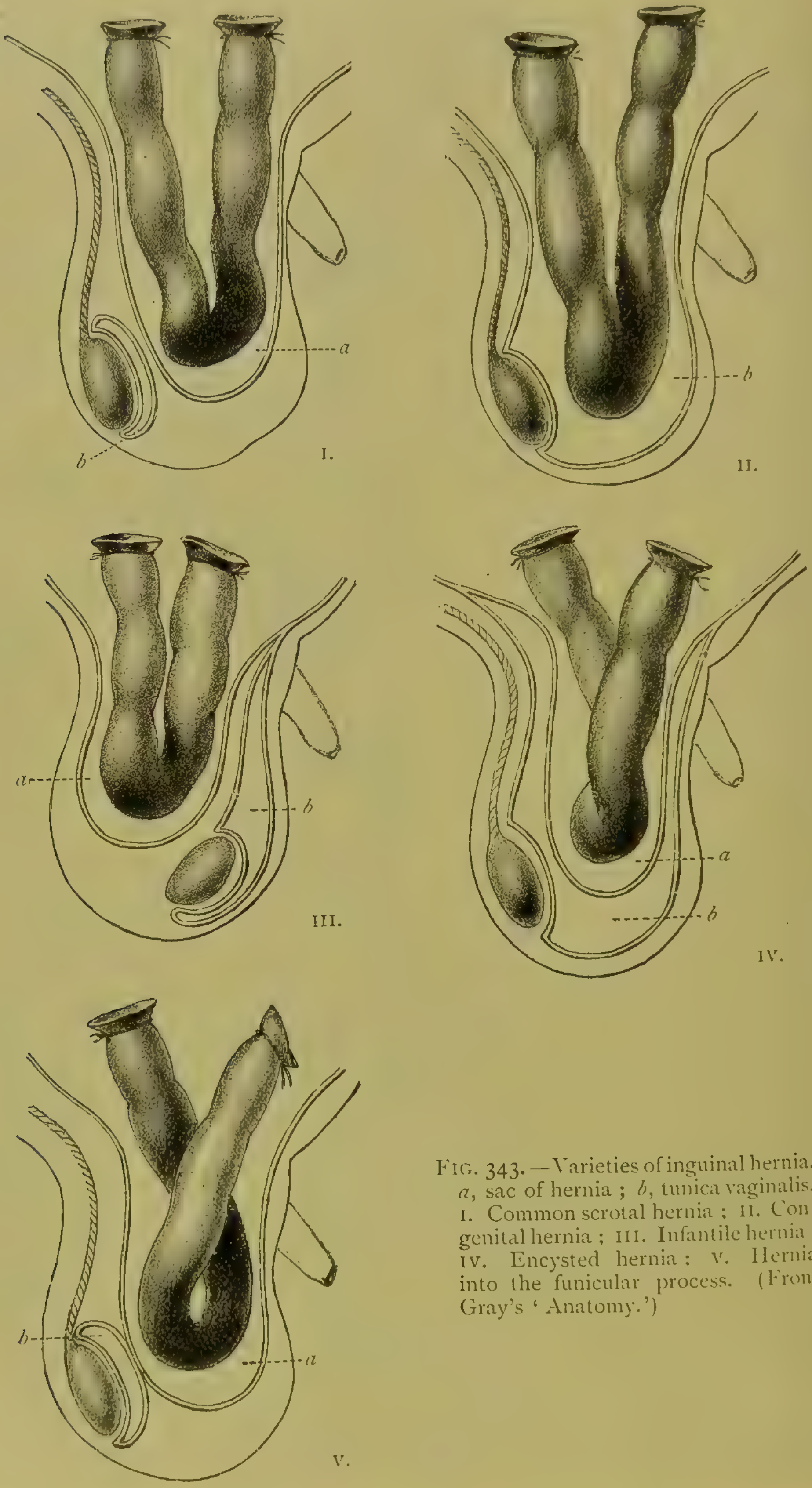

FIG. 343.—Varieties of inguinal hernia. *a*, sac of hernia; *b*, tunica vaginalis. I. Common scrotal hernia; II. Congenital hernia; III. Infantile hernia; IV. Encysted hernia; V. Hernia into the funicular process. (From Gray's 'Anatomy.')

not come in contact with the testicle, for it is separated from it by the occlusion which has taken place. This is known as *hernia of the funicular process* (fig. 343, v). In the female, in like manner, the process of peritoneum which accompanies the round ligament may remain patent, though it is usually obliterated at birth. If it should remain patent, under rare circumstances a hernia may descend into it, and constitute a form of hernia analogous to the congenital hernia in the male. When, however, an inguinal hernia occurs in the female—and it is the common form of hernia found in female children—it is usually of the acquired variety.

Interstitial hernia.—In connection with the subject of the defective development of the coverings of the testicle, must be mentioned a form of hernia which is known as *interstitial hernia*, and which is usually a variety of the congenital form (fig. 344). In these cases there is a diverticulum or pouch, springing from the patent funicular process, or patent canal of Nuck, which forms a sac into which the gut may find its way. The sac is situated between the layers of the abdominal parietes, and may be placed either between the external oblique muscle and the subcutaneous structures; or between the internal and external oblique; or between the transversalis fascia and the peritoneum. Two explanations have been given of the mode in which this diverticulum is produced. Some believe that it is a congenital malformation, and that an additional sac is formed as the result of some aberration in the developmental process; but there is no evidence that this is so. It seems more probable that it is due to some tightness of the external abdominal ring, which prevents the bowel descending through it, and therefore the bowel forces its way, pushing the sac before it, in the direction in which there is least resistance. This is rendered the more probable by the fact that interstitial hernia is usually associated with undescended testicle.

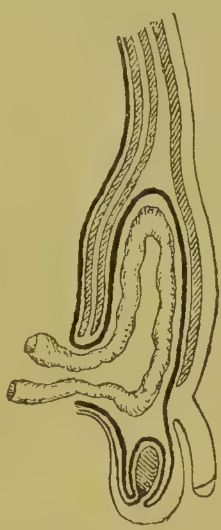
FIG. 344.—Interstitial hernia. Diagrammatic.

Symptoms.—Nothing much need be said about the signs of a complete inguinal hernia, as they have been already described (page 864). It forms a tumour in the scrotum, which lies generally above and in front of the testicle, and is pyriform in shape. Its neck can be traced upwards into the inguinal canal, the cord generally lying behind it, with its constituents obscured by the presence of the hernia. In many cases of oblique hernia there is a fullness along the course of the inguinal canal, but when the hernia is of long standing the mouth of the sac becomes enlarged, and the internal ring becomes displaced downwards and inwards, so that it is situated directly behind the external ring; the hernia will then be felt to project directly backwards from the external ring, there will be no oblique fullness in the situation of the inguinal canal, and it is impossible to diagnose it, by examination, from a direct inguinal hernia. The diagnosis of femoral hernia from a complete inguinal hernia is usually easy; but in some cases of large femoral herniæ, which have a tendency to roll up over Poupart's ligament, a mistake may be made. The diagnosis can, however, be settled by placing the finger on the spine of the os pubis: the neck of the femoral hernia is external to this point; that of an inguinal hernia internal. It should be noted also whether the neck of the sac is above Poupart's ligament, when it will be an inguinal hernia, or below it, as in the femoral variety. The diagnosis of a complete inguinal hernia from other scrotal swellings ought not to be difficult. The swellings with which it is liable to be confounded are hydrocele, hæmatocele, solid tumours of the testicle, inflamed testicle, and varicocele. In all these, except varicocele, the diagnosis may at once be made by grasping the structures which pass through the external abdominal ring with the finger and thumb. If the case is one of a scrotal swelling other than a hernia or a varicocele, the structures of the cord will be felt distinctly passing into the canal, and the swelling will be completely isolated from the ring. In case of a hernia, on the other hand, the limit cannot be defined, and the structures of the cord will be masked by the neck of the hernia. The only cases in which possibly there might be a fallacy in this test are where the funicular process is patent throughout the greater part of its length, but closed at the internal abdominal ring. If a collection of fluid were to take place under these circumstances into the tunica vaginalis, it would distend the funicular process, and the spermatic cord would be obscured upon grasping the scrotum just below the external ring. But in these cases translucency and other physical signs of hydrocele would be present. The diagnosis between varicocele and hernia need not be dwelt upon. The peculiar swelling which is produced by varicose spermatic veins is so characteristic that no mistake is likely to be made except by the most careless observer. In the female, a labial hernia may be mistaken for a cyst of the labia; but the latter is irreducible, well defined, and limited above.

In **incomplete hernia,** or **bubonocele,** there is a small rounded or oval swelling in the course of the inguinal canal, in which there is an impulse on coughing. It is generally movable, and is reducible under ordinary circumstances. Its diagnosis is sometimes difficult, and it is liable to be mistaken for encysted hydrocele of the cord, enlarged gland, retained testicle, hæmatocele of the cord, fatty tumour, and chronic abscess. Those swellings which are situated in the cord, such as encysted hydrocele and hæmatocele, may be at once differentiated, by the fact that they are irreducible if the testicle is fixed by the hand so as to make traction on the cord, though they may be movable and capable of being partially pushed upwards into the abdomen if no traction is made. From a retained testicle it may be diagnosed by the absence of the testicle from the scrotum, and by the clear defined upper border of the swelling. It must be borne in mind, however, that a hernia is very frequently associated with an undescended testicle. From enlarged glands the diagnosis can be made by introducing the finger into the canal through the external ring, by invaginating the scrotum; the swelling will then be found to be superficial to, instead of being in, the inguinal canal. The same plan may be adopted in diagnosing a chronic abscess in the abdominal wall from a bubonocele. The consistence of the swelling also, which is soft and fluctuating, distinguishes it from the definite tense outline of a hernia. Fatty tumours are occasionally met with in the inguinal canal, and can be recognised by their defined upper margin, which may sometimes be made out to be lobulated, and by the absence of any impulse on coughing.

The existence of a congenital hernia may generally be surmised by the history of its sudden descent, in contradistinction to the gradual descent of an acquired hernia. For it must be remembered that a congenital hernia is not necessarily a hernia which is apparent at birth, but one which takes place through a congenital opening.

Direct inguinal hernia is far less common than the oblique. In these cases the hernia protrudes directly through the external abdominal ring; the sac being formed by that portion of the peritoneum which lines Hesselbach's triangle, a space bounded externally by the epigastric artery, internally by the outer border of the rectus muscle, and below by Poupart's ligament. Direct hernia, in the male at all events, is always of the acquired type. Two varieties of this hernia are described: one where the hernia leaves the abdomen to the inner side of the obliterated hypogastric artery; the other, where it emerges to the outer side of this structure. This makes a slight difference in the coverings of these two forms. In the one to the outer side of the obliterated artery there are the same coverings as the ordinary oblique hernia; whereas the one to the inner side, which is the more common of the two, has the conjoined tendon as a covering, instead of the cremasteric muscle and fascia. This is a matter of very little importance; the essential point to bear in mind is that one form of direct hernia is in close relation with the epigastric artery, and therefore, in dividing the stricture in a strangulated inguinal hernia, the incision should always be made directly upwards, that is to say, parallel to the artery. Under these circumstances the epigastric vessels, whether the hernia is oblique or direct, cannot be wounded.

Femoral hernia.—Femoral hernia occurs more commonly in the female than in the male, although it is by no means rare in men. It most usually occurs between the ages of twenty and forty, and is uncommon in female children. It is never of the congenital form, but is always acquired. The hernia passes out through the crural ring and descends vertically through the crural canal, and then bends forwards through the saphenous opening to appear under the skin. It is in close relation on its outer side with the femoral vein, from which it is separated by a thin septum; the spermatic cord or the round ligament passes above and internal to the femoral ring, but is superficial to it; while the epigastric vessels skirt its upper and outer margin. The pubic branch of the obturator artery passes round the ring in its passage to anastomose with the pubic branch of the epigastric, and varies considerably in size. In one case out of three and a half the obturator artery arises from the deep epigastric, and in some of these cases curves inwards along the free margin of Gimbernat's ligament to reach the obturator foramen; under these circumstances it is in danger of being wounded in dividing the stricture. In the majority of cases, however, in which the obturator artery has this anomalous origin, it skirts round the external iliac vein, on the outer side of the ring, and is then in no danger of being wounded. A femoral hernia, after emerging from the saphenous opening, has the following coverings: skin and subcutaneous tissue, cribriform fascia, anterior layer of the femoral sheath, septum crurale, sub-serous areolar tissue, and peritoneum. A femoral hernia is usually small, and, after it has emerged through the saphenous opening, has a tendency to pass obliquely upwards and outwards along the line of Poupart's ligament; and it is under these circumstances that it is liable to be mistaken for an inguinal hernia. Femoral hernia most frequently consists of intestine, and generally ileum; it is very liable to become strangulated, but is not often irreducible. Omental hernia is not nearly so common in the femoral region as in the inguinal; when it does occur, the omentum is very liable to contract adhesions, and the hernia to become irreducible.

Symptoms.—The signs of a femoral hernia are the ordinary signs of hernia—a reducible swelling, with an impulse on coughing, in the groin to the inner side of the femoral vessels, and outside the pubic spine. It may be mistaken for some other affections. An enlarged gland situated in the crural canal may closely simulate a small hernial tumour, and indeed, in fat persons, a diagnosis can sometimes hardly be made without an exploratory incision. In some not uncommon cases a small hernia may be found underneath an enlarged gland, which makes the diagnosis still more uncertain. As a rule, a gland is defined and separable from neighbouring parts; it is movable, and has no impulse on coughing. A femoral hernia may be mistaken for a psoas abscess: in both there is a reducible tumour, with an impulse on coughing; but in the psoas abscess the swelling is outside the femoral artery, and there is distinct fullness in the iliac fossa, and fluctuation can usually be obtained by alternating pressure above and below Poupart's ligament. Varix of the saphena vein is said to simulate femoral hernia; but if the swelling is reduced and pressure is made over the femoral ring, and the patient stands up, the swelling of varix will reappear; that of hernia will not.

Treatment.—Femoral herniæ, as a rule, cause far less inconvenience and pain than inguinal herniæ, and many of these cases may very well be treated by making the patient wear a truss. A radical cure is not so often called for as in the inguinal variety. If they become strangulated, the treatment must be conducted on the principles enunciated above (page 877). In dividing the stricture the incision should be made upwards and inwards, and, after the gut has been reduced, one of the methods enumerated for effecting a radical cure should be adopted (page 871).

Umbilical hernia.—There are three different varieties of umbilical hernia: 1. congenital; 2. infantile; 3. umbilical hernia of adults.

1. **Congenital,** or **exomphalos.**—The congenital umbilical hernia is due to an arrest in the process of development, from imperfect closure of the ventral plates. It may vary very much in degree: the abdominal wall may be unclosed from the ensiform cartilage to the symphysis pubis, and the whole, or almost the whole, of the abdominal viscera may be extruded. This condition is incompatible with life, and is only rarely met with. More commonly the ventral plates have met together above and below, and the deficiency is only at the neighbourhood of the umbilicus. The intestine, generally the cæcum and adjoining portion of the ileum, then protrudes and becomes enclosed in the tissues of the cord, which is generally to be seen issuing from the summit of the swelling. The coverings are very thin, and the coils of intestine can usually be seen through them. If left untreated, the cord separates, the abdominal cavity is opened, and the child dies of peritonitis. In addition to these cases, which are the most common, there may be a minute opening in the abdominal wall, through which a very small portion of intestine, or in some cases a Meckel's diverticulum, may be protruded, and may be overlooked at the time of birth. Cases have been recorded where, in such a case, the gut has been included in ligaturing the cord. The only treatment is to at once open the sac, reduce the intestine, and close the gap by sutures.

2. **Infantile.**—This is the umbilical hernia of infants, and is an exceedingly common affection. It is not a congenital condition, but appears some weeks after birth, and is caused by the yielding of the umbilicus. It is predisposed to by phimosis or constipation, the straining in attempting to pass water or defæcate causing the soft cicatricial tissues to give way. It is common to both sexes, but is much more amen-

able to treatment in the male than in the female. It presents a soft button-shaped swelling at the umbilicus, which becomes tense when the child cries or strains. It appears to cause absolutely no inconvenience, and has a tendency to undergo spontaneous cure as the child grows. The treatment consists in simply applying a transverse piece of strapping so as to approximate the edges and prevent the protrusion. If the child is the subject of phimosis he should be circumcised, and his bowels should be regulated.

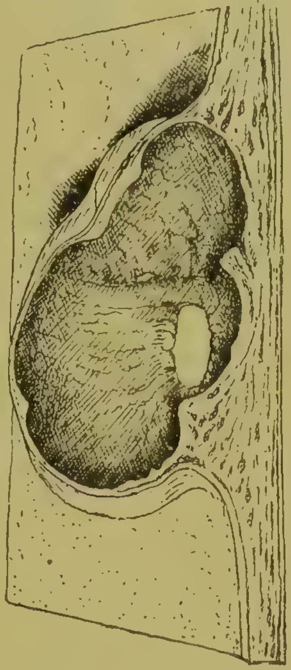

FIG. 345.—Umbilical hernia. (From the Museum of St. George's Hospital.)

3. The **umbilical hernia of adults** (fig. 345).—This name is somewhat of a misnomer, as the hernia is not situated at the umbilicus, but either just above or below it, more frequently in the former situation. It is much more common in women than in men, and occurs in women who have borne children and have large pendulous abdomens. It usually occurs in women over thirty, increases gradually, and may eventually attain a very large size. It most frequently contains the transverse colon and omentum, and to this may be superadded coils of small intestine. These structures become matted together by adhesions, and are very often adherent to the sac, so that the hernia is very frequently irreducible. The coverings are thin. The peritoneum is often so thinned and attenuated that it is scarcely recognisable. The skin and subcutaneous tissues over the tumour are also thinned and stretched, so that the coils of intestine may be seen through the covering. The integumental structures are liable to ulcerate and give way. A considerable deposit of fat often takes place in the herniated omentum, and this gives to the tumour a lobulated appearance, and is a further cause of its irreducibility. It is very liable to become obstructed, and this obstruction may, and often does, run on to strangulation.

Symptoms.—There is no difficulty in recognising the condition. A tumour is to be seen in the neighbourhood of the umbilicus, which is usually irregular and lobulated. If of large size, it is pendulous and has a rounded and wide base. There is a distinct impulse on coughing, and it may or may not be reducible; usually the latter. The patient is frequently troubled with dyspeptic symptoms, colicky pains, constipation alternating with diarrhœa, and often nausea and vomiting.

Treatment.—In those cases where the hernia is reducible, an umbilical truss should be worn. This consists of a modified Salmon and Ody's truss, consisting of a plate over the site of the protrusion, and another over the back; the two being connected by a spring, which is attached to the front plate by a universal joint. In very fat patients there is great difficulty in keeping this in its place. If the hernia is irreducible, a concave pad fixed in an abdominal belt should be worn; or if the hernia is very large, a bag truss must be adapted. As an irreducible umbilical hernia is a constant source of discomfort and danger to the patient, an operation for the radical cure should always be seriously considered. Those cases where the hernia is not of very great size, and the patient is not very fat, are the ones suited to operation. If the hernia is large and the patient fat, there is no room in the abdomen for the prolapsed structures ; and if the operation is attempted it will probably end in failure, from inability on the part of the surgeon to reduce the contents of the sac. If, however, the hernia is not very large, though the patient is corpulent, it is justifiable to attempt, by dietetic and other measures, to reduce the corpulency, and if this can be done, to then proceed to the operation. The manner of performing it has already been described (page 872).

Strangulation of an umbilical hernia is always a very serious condition ; but many of the cases of so-called strangulation are really more of the nature of obstruction—a condition which is almost as serious as strangulation, and may lead to the death of the patient, unless relieved by operation. Herniotomy itself in these cases is attended with a very heavy mortality, though it has been considerably reduced in recent years, since the establishment of antiseptic measures, and since it has become the practice to shut off the peritoneal cavity from the external wound. The operation consists in opening the sac by a vertical incision in the middle line, dividing the stricture, and reducing the intestine, after the adhesions, if any exist, have been separated. The omentum is now freed from the interior of the sac, tied in strands, and removed. The sac is then excised, the cut edges of the peritoneum sutured together with a continuous catgut suture, the opening in the abdominal wall securely closed by buried sutures, and the edges of the external wound adjusted. Howard Marsh, in order to save time in the performance of the operation, recommends that the sac and omentum should be removed together, without any attempt being made to separate them. He makes a semicircular incision on either side of the sac, so as to include in an elliptical wound the skin over the front of the tumour, leaving only so much on either side as will allow of the closure of the wound in the middle line, without tension. He then separates the subcutaneous tissues from the outer surface of the sac on either side, down to its neck. The sac is now opened ; the stricture, if one exists, is divided, and the intestine is reduced. The surgeon then defines and isolates the omentum at the spot where it passes through the abdominal wall, ligatures it in segments, and divides it just beyond the ligature. By now cutting through the neck of the sac external to the ring, the omentum, the sac, and the skin covering the front of it are removed in one mass. The cut edges of the sac are now united, the ring obliterated by buried sutures, and the external wound closed.

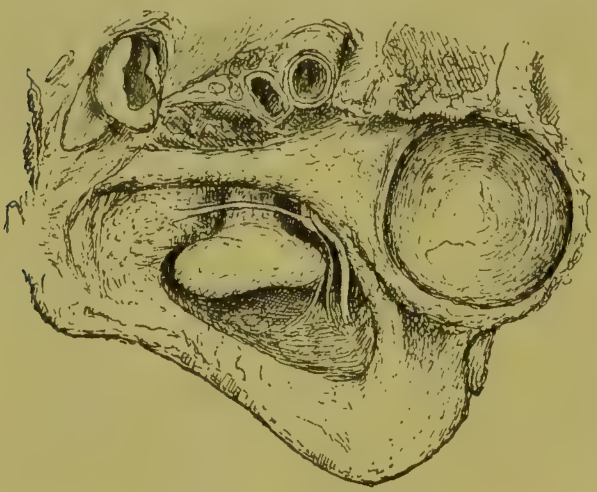

FIG. 346.—Obturator hernia. There is also a small inguinal hernia just appearing at the external abdominal ring. (From the Museum of St. George's Hospital.)

Obturator hernia (fig. 346) is where the hernia descends through the upper part of the obturator foramen. It is most common in women who are advanced in life, and usually consists of intestine, omentum being rarely found in these cases. It is not often diagnosed, except it becomes strangulated, and then, in addition to the ordinary signs of intestinal obstruction, there is to be found a tumour, or at all events a perceptible fullness just below the spine of the os pubis, to the inner side of the femoral vessels. In very nearly half the recorded cases, pain was complained of about the inner side of the knee, owing to pressure on the obturator nerve. This symptom and pain over the site of the rupture, increased by moving the thigh and especially by tensing the obturator externus, may give some clue to the nature of the case. An examination by the vagina or rectum may assist the surgeon in arriving at a diagnosis.

The **treatment** is usually confined to those cases where strangulation has occurred. An incision should be made along the border of the adductor longus, and this muscle exposed and separated from the pectineus, when the tumour will come into view. After the sac has been opened, the stricture should be divided in an upward direction, as the obturator vessels are, as a rule, at the outer and posterior part of the sac.

Ventral hernia.—By the term ventral hernia is meant a protrusion through some part of the abdominal wall, other than those weak spots, which are the common site of hernia, the internal abdominal ring, the femoral ring, and the umbilicus. They may be of two or three different varieties. (*a*) The most common form of ventral hernia is the traumatic ventral hernia, where a wound or opening has been made in the abdominal wall, or where an abscess has formed in this situation, and the cicatricial tissue which closes the gap has yielded under the pressure of the contained viscera. This form may also occur after rupture of the abdominal muscles (fig. 347). The hernia presents an ill-defined bulging, apparent when the patient is in the erect position, and is often attended by a feeling of weakness in the part, and by colicky and dyspeptic symptoms. (*b*) Occasionally a ventral hernia may be produced by a separation of the two recti in the middle line, and a thinning of the linea alba, generally in women who have borne children. The hernia then takes the form of an elongated swelling, which appears in the median line of the abdomen upon making any muscular effort. It is not usually attended by any serious

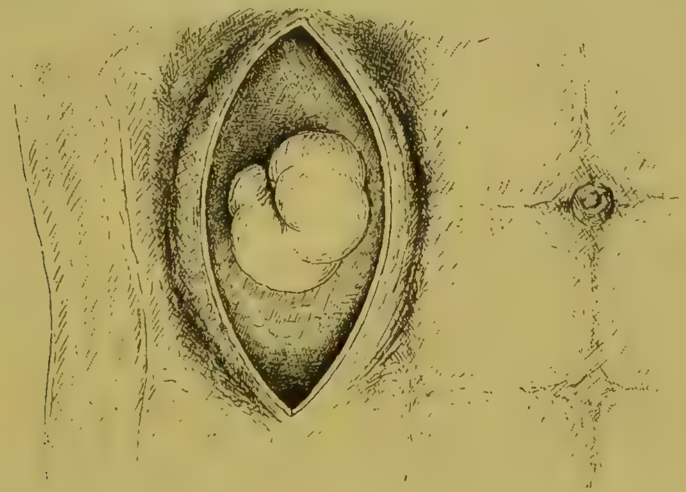

FIG. 347.—Ventral hernia following rupture of the rectus muscle. (From the Museum of St. George's Hospital.)

symptoms. (*c*) It occasionally happens that a minute perforation may exist in the linea alba or one of the lineæ semilunares, and through this the sub-serous fatty tissue finds its way into the subcutaneous tissue. It here begins to grow, and forms a small localised fatty tumour. As it grows, it draws the part of the peritoneum from which it originally sprung through the perforation, and thus a sac is formed outside the abdominal wall, into which a knuckle of intestine may find its way. In these cases a small circumscribed swelling is to be felt in one of these situations, which is partially, but not completely, reducible. It often gives rise to very considerable pain, especially during the movements of the body, and in some cases to colic and symptoms of abdominal disturbance.

Treatment.—The treatment of the traumatic ventral hernia consists in either applying a supporting belt, or, if the condition gives rise to any inconvenience, in incising the skin and other structures over the hernia and exposing the peritoneum. The edges of the divided or separated muscles are to be defined and refreshed, and brought into apposition by buried sutures. The external skin wound is then closed, with or without removal of superfluous skin. There is no necessity to open the peritoneal cavity. In the cases of separation of the recti muscles, the only treatment that is necessary is a well-fitting abdominal belt. In those cases of ventral hernia which are due to the protrusion of the sub-serous fat, the tumour should be exposed by incision, the fatty mass removed, and the opening closed by deep suture. (*d*) A special form of ventral hernia is known as *lumbar hernia*. This is a hernia which protrudes in the loin, either through Petit's triangle—a space between the borders of the external oblique and the latissimus dorsi, just above the crest of the ilium—or through a space just below the last rib, where the aponeurosis of the transversalis is supported only by the latissimus dorsi. It may arise from wound or abscess, or it may be spontaneous. It presents the ordinary signs of hernia, and care must be taken not to mistake it for a lumbar abscess. The treatment of these cases usually consists in applying a suitable truss.

The other forms of hernia—sciatic, perineal, ischio-rectal, pudendal, vaginal, and diaphragmatic—are so rare that they require no special description.

Post-peritoneal or **internal hernia.**—Occasionally a hernia of the gut takes place into one of the peritoneal fossæ. This may occur either in the neighbourhood of the duodenum, the cæcum, or the sigmoid flexure, or into the lesser cavity of the peritoneum through the foramen of Winslow.

Duodenal hernia may occur in two situations. (1) The most common variety is situated to the left of the abdomen, and takes place into the fossa of Landzert—a fossa formed by the raising of a fold of peritoneum around the inferior mesenteric vein. This fold is called the *plica venosa*, and forms the anterior margin of the sac of the hernia, which lies in contact with the posterior abdominal wall to the left side of the lumbar vertebræ. When a large quantity of gut finds its way into the pouch, it projects behind the descending colon and appears on its outer side. (2) The other form of duodenal hernia is situated to the right of the abdomen, and the gut finds its way into the fossa of Waldeyer—a fossa situated in the first part of the meso-jejunum, immediately behind the superior mesenteric artery, and below the duodenum.

Duodenal hernia, unless strangulated, practically gives rise to no symptoms, and in many cases is found accidentally at post-mortem examinations of patients who have died of other diseases. When strangulated, in addition to the symptoms of acute intestinal obstruction, it gives rise to a characteristic appearance of the abdomen: a tumour in the central part, surrounded by an area of depression, which corresponds to the position of the colon. The tumour can be marked out distinctly by palpation, and is resonant on percussion; in it, on auscultation, distinct gurgling sounds may be heard. Owing to compression of the inferior mesenteric vein in left duodenal hernia, the hæmorrhoidal veins and the veins on the anterior abdominal wall may be enlarged.

Peri-cæcal hernia.—There are four folds of peritoneum in the neighbourhood of the cæcum, formed mainly by branches of the ileo-colic artery, and into the fossæ or pouches formed by these folds a portion of gut may find its way, constituting a peri-cæcal hernia. The two fossæ which are most frequently the site of this condition are the ileo-appendicular or ileo-cæcal fossa, which is situated between the ileo-appendicular fold and the mesentery of the appendix; and the retro-colic fossa, a fossa situated behind the colon, and sometimes reaching as high as the kidney. But herniæ into some of the other fossæ have been described.

Intersigmoid hernia.—Hernia into the intersigmoid fossa has been recorded in a few instances. This fossa is a pouch of peritoneum in the sigmoid meso-colon, caused by a reflection of the membrane round the sigmoid artery. The opening into the pouch may be seen by drawing the sigmoid flexure upwards. Into the fossa a portion of gut may find its way, and if it becomes strangulated gives rise to symptoms of acute intestinal obstruction.

Hernia into the foramen of Winslow.—This form of post-peritoneal hernia only occurs in those cases where there is some abnormality about the foramen, and is very uncommon. A hernia in this situation, like other forms of post-peritoneal hernia, rarely gives rise to symptoms unless strangulated, when, in addition to the symptoms of acute intestinal obstruction, there is a painful swelling in the epigastric region, which is resonant on deep percussion.

CHAPTER XIV

INJURIES AND DISEASES OF THE PELVIS AND PELVIC PORTION OF THE INTESTINAL CANAL

FRACTURES OF THE PELVIS

Fractures of the pelvic bones are usually the result of severe violence, and are often complicated by injury of some of the contained viscera. They may be conveniently divided into fractures of the false and true pelvis; the pelvic ring being broken in the latter, but not in the former.

Fractures of the false pelvis are usually the result of direct violence, such as severe blows, the fall of a heavy weight or masonry on the body, or from being run over, and may vary much in extent, from a chipping off of a small portion of the crest, to extensive comminution of the bone.

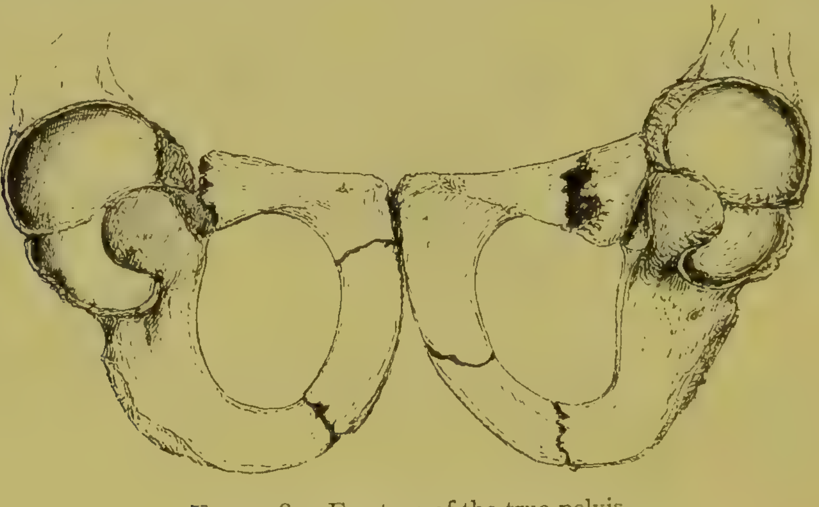

Fig. 348.—Fracture of the true pelvis. (From the Museum of St. George's Hospital.)

Symptoms.—The patient complains of great pain in the part, especially on making any movement or during any expiratory effort, such as sneezing or coughing. There is usually considerable swelling and bruising, and on pressing the hand against the crest of the ilium it will be felt to move under the pressure, and occasionally crepitus may be elicited. As a rule these fractures unite readily, and all the treatment that is necessary is to keep the patient in bed, with the shoulders somewhat raised and a pillow under the knees, to relax the abdominal muscles.

Fractures of the true pelvis (fig. 348).—Fractures of the bony ring of the pelvis are usually produced by some crushing violence, as a buffer accident or from the patient being run over. The most common fracture is a vertical one through the obturator foramen, passing through the horizontal ramus of the os pubis and the ascending ramus of the ischium. These fractures may sometimes be double, occurring on both sides of the body, or may be complicated with a fracture near the sacro-iliac joint. They are frequently associated with injury to the pelvic viscera, the urethra, the bladder, and more rarely the rectum, the vagina, or the small intestine, and still more uncommonly the uterus.

Symptoms.—There is the history of a severe injury, and the patient is collapsed. Great pain is complained of in the lower part of the abdomen, increased by moving or coughing. The patient is unable to stand, and if he attempts to do so, feels as if his body were falling in pieces. Upon grasping the two crests of the ilia and moving them on each other, crepitus will be detected. There is rarely any deformity, but there may be some local bruising over the pubes. If any of the contained viscera have been injured, the collapse is greater, and there will be special symptoms indicating the injury. If the urethra has been lacerated, blood will trickle from the meatus ; if the bladder has been torn, there will be inability to pass water, and on introducing a catheter, merely a little bloody fluid will be withdrawn ; if the rectum or vagina has been injured, there will be discharge of blood from these passages, and the finger, if introduced, may feel the penetrating fragment of bone.

Treatment.—The patient should be placed on his back on a bed with a fracture bottom, and a broad flannel roller or belt applied around his pelvis. The treatment of visceral complications will be described in the sequel. The patient should be kept quiet for eight weeks, after which he may be allowed to get about on crutches.

Fracture of the acetabulum.—The acetabulum may be fractured in two situations : either a portion of the rim may be broken off ; or the bottom of the cavity may be fractured in various ways, from a slight fissure to a severe comminution, so that the head of the femur is displaced into the pelvic cavity. Occasionally in young persons a separation may take place between the three constituent parts of the innominate bone, constituting the Y-shaped fracture of the acetabulum.

Fractures of the lip of the acetabulum are usually produced by the head of the femur being violently driven against it. The upper and back part of the rim is the portion most frequently broken off, and the head of the femur becomes displaced. The symptoms are those of dorsal dislocation. The dislocation is easily reduced, possibly with crepitus, but has a great tendency to recur, and long-continued extension is required to prevent shortening and deformity. Even with every care a certain amount of permanent displacement, and consequent lameness, is likely to result.

Simple fissure across the acetabulum is not accompanied by any definite symptoms beyond pain and impairment of the movements of the joint. But where the acetabulum is extensively comminuted, the head of the bone may be driven inwards and project into the pelvic cavity. The injury is usually produced by falls on the trochanter, and simulates dislocation, as the thigh is shortened, adducted, and flexed ; crepitus may, however, be felt, and the head of the bone may be detected by the finger introduced into the rectum. The separation of the bone into its three component pieces is caused by a similar accident ; the symptoms are the same, but it occurs only in young people. These accidents are usually the result of very extreme violence, and are often associated with other lesions, and terminate fatally. The treatment should consist in making an effort to free the head of the bone, and then applying a long splint and making extension.

Fracture of the tuber ischii has occasionally been caused by falls from a height on to the buttocks. The diagnosis can usually be made by grasping the tuberosity and moving it from side to side, when crepitus will be felt.

Fracture of the sacrum.—The sacrum is not frequently fractured; when it is, the fracture is commonly transverse, at the lower part of the bone, and is produced by direct violence. It is often complicated by injury to the nerves of the sacral plexus, and incontinence of fæces and loss of power over the bladder are common symptoms. The lower fragment is usually displaced forwards, and may press upon the rectum and cause obstruction. The irregularity of the outline of the sacrum, and the displaced lower fragment felt by introducing the finger into the rectum, establish the diagnosis.

The **treatment** consists in replacing the fragment and keeping the patient quiet in bed until union has taken place. If there is any tendency for the displacement to recur, Hamilton recommends that the patient should be given opium and carefully dieted, so that constipation may be induced and the loaded rectum may press on the fragment and help to keep it in its place.

Fractures of the coccyx.—The coccyx may be broken by blows or kicks. There is great pain in sitting, walking, or in defæcation. By introducing the finger into the rectum, the displaced portion of bone will be felt, and crepitus will be detected on moving it.

The **treatment** consists in replacing the fragment and keeping the patient in the recumbent position until union has taken place. The bowels should be restrained from acting for as long as possible.

DISEASES OF THE PELVIS

Disease of the sacro-iliac joint.—The sacro-iliac joint may be the seat of a pyæmic affection or of tuberculous disease. Of the former condition it is not necessary to say anything; the disease runs the course of pyæmic affections of joints, and if the abscess is opened and drained it will probably heal eventually, if the patient survives the general condition.

Tuberculous disease of the sacro-iliac joint is a by no means uncommon affection. It occurs most frequently in young adults, under the age of thirty, but is also occasionally met with in children. It usually commences as a tuberculous ostitis, especially attacking that portion of the ilium which forms the posterior border of the joint. It runs the ordinary course of tuberculous affections of joints, and terminates in complete destruction of the articulation and the formation of a chronic abscess.

Symptoms.—The symptoms of this affection vary considerably. In some cases the formation of a soft fluctuating swelling over the joint may be the first sign which attracts attention, preceded, it may be, by a certain amount of aching pain after exertion. In other cases the symptoms are much more marked. The patient complains of constant aching pain, worse at night, and increased by walking, standing, or by making any violent expiratory effort. This pain is accompanied by a feeling of weakness and a sensation that he is unable to support the body on the affected leg, and if he attempts to do so, he complains that there is a feeling that his body was 'coming in two.' If he walks he does so with a decided limp, and usually requires the assistance of a stick. Upon examination there is found to be apparent lengthening on the affected side, from obliquity of the pelvis. Great pain is experienced on jarring the crests of the two iliac bones together, or on palpating over the diseased joint, and there may be some swelling in this situation. After a time abscess forms, and usually points immediately behind the joint; but it may track upwards and point in the lumbar region; or it may pass down into the pelvis and present in the ischio-rectal region; or it may burrow through the iliac fossa and point in the groin.

Treatment.—The treatment in the early stage is the same as that for tuberculous disease of other joints—absolute rest maintained for some long period. The patient should be kept strictly in bed, flat on his back, and the pelvis should be encircled by a softly padded belt. The general health must at the same time be attended to. Under this treatment, if the disease has been recognised in its early stage and the treatment is continued for a sufficiently long time, perfect recovery may take place. If abscess forms, an operation must be at once undertaken. The matter must be evacuated by a free incision, and the whole of the diseased tissues and tuberculous material scrupulously scraped or gouged away, and the part thoroughly irrigated. After the cavity has been cleansed of all morbid material it should be filled with iodoform emulsion, and the wound closed. The operation may require repeating; but by perseverance, in many cases, excellent results have been obtained.

INJURIES AND DISEASES OF THE RECTUM AND ANUS

Injuries of the rectum.—Foreign bodies may be occasionally thrust violently into the rectum, or a patient in falling may become impaled by an elongated foreign body, such as a stick or broom handle, passing into the rectum. Under these circumstances the foreign body may transfix the gut and enter the peritoneal cavity or wound the bladder (fig. 349), when the case will almost certainly terminate fatally. In other cases it may merely tear the sphincter and lacerate the perineum. These cases are to be treated on general principles.

Foreign bodies are occasionally introduced into the rectum by the patient himself. These are often difficult to extract after they have passed the external sphincter. In a patient under my care who had introduced a glass bottle used for pomatum into his rectum, in endeavouring to reduce a prolapsus from which he suffered, the greatest difficulty was experienced in extracting it, and it was only after the sphincter had been completely stretched that it was at last accomplished by means of a large pair of lithotomy forceps.

MALFORMATIONS OF THE RECTUM AND ANUS

Occasionally at birth the rectum and anus may be found completely and properly formed, but the passage is occluded by the agglutination of the margins of the anus. This is a matter of very little importance; the thin membranous septum may be easily broken down by the oiled finger introduced into the rectum, and this is all that is necessary to effect a cure.

In other cases an **imperforate anus** may be present, and this may assume several different forms, for the right understanding of which it is necessary to allude briefly to the mode of development of this portion of the intestinal canal. The rectum is developed from the lower part of the hind gut, which is the closed tube at the caudal end of the inflection of the blastodermic layers from which the alimentary canal is formed. This grows down into the pelvis of the embryo, carrying the terminal branch of the inferior mesenteric artery with it, and meets an inflection of the epiblast, which takes place at the situation of the future anus. The two portions are at first separated by the closed ends of the two cæcal tubes, but subsequently a solution of the septum takes place and the two tubes communicate.

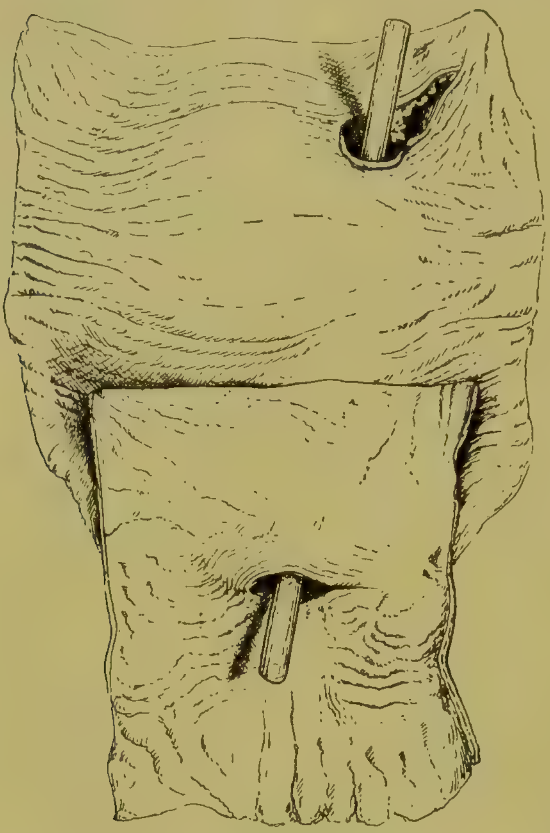

FIG. 349.—Lacerated wound of the rectum and bladder, produced by the patient falling backwards on to the leg of a chair. (From the Museum of St. George's Hospital.)

The following are the principal varieties of imperforate anus, which may arise from some imperfection in the development of these parts.

1. The septum between the two portions of embryonic gut—the end of the hind gut and the involuted epiblast—known as the *proctodæum*—may not become dissolved. Under these circumstances, the external parts will be found to be natural and the anus fully formed, but the child cannot defæcate. Upon introducing the finger, it will be found that it cannot be passed above half an inch, and the septum will be felt occluding the tube. Above this the surgeon will detect with his finger the bulging lower end of the hind gut, full of meconium.

The **treatment** consists in placing the infant in the lithotomy position, and exposing the septum with an ordinary nasal speculum and reflected light. When this can be plainly seen, a tenotomy knife should be passed into the boggy swelling above, and along this a pair of narrow-bladed dressing forceps; these are then opened, so as to dilate the wound in the septum sufficiently to admit the introduction of the little finger. The meconium will at once escape. The artificial opening thus made has a tendency to contract, and the nurse or mother should be instructed to introduce her little finger, well oiled, through it at least twice a day.

2. No involution of the epiblast may have taken place, and the anus may be entirely undeveloped, though the rectum—that is, the terminal end

of the hind gut—may be fully developed. Under these circumstances, there will be no appearance of anus; but upon making the child cry, a soft bulging swelling will be seen and felt in the situation of the anus. In these cases, the child having been placed in the lithotomy position, an incision is to be made at the proper site of the anus, and the tissues divided until the meconium is evacuated. The mucous membrane of the bowel is then to be drawn down, and attached all round to the margins of the external incision. In these cases, after the operation there will be for some time entire want of control of the fæces, but the power of retaining them is acquired after a time.

3. The rectum may be undeveloped in whole or in part, and this may be either with or without the formation of an anus (fig. 350). Any degree of want of development of rectum may be present: the colon may terminate in any part of its descending portion, and there may be no attempt whatever to form a rectum; or, on the other hand, the rectum may be developed in its upper part, and may terminate one, two, or more inches from the anus. In those cases, which are uncommon, where the rectum is deficient in its development, but the anus is fully formed, no bulging would be felt upon the introduction of the finger into the anus, nor would it be seen upon examination with a speculum. Probably it is right in these cases to make an exploratory puncture through the anus, in the hope of reaching the meconium; but if this fails, the only resource is colotomy. In the majority of cases where the lower part of the rectum is undeveloped, there is also an absence of the anus. In these cases an incision is first to be made at the site of the anus, and the parts carefully dissected upwards and backwards along the concavity of the sacrum, taking care to keep strictly in the middle line. This dissection may be carried to the depth of an inch and a half or two inches, and the bulging end of the hind gut carefully sought for; if it is found, it must be opened, and the edges of the opening brought down and attached to the external incision, if possible; if not, a pewter tube must be inserted and kept constantly there, as otherwise the channel which has been made will contract into a narrow fistulous track. When the gut cannot be found, the only resource is colotomy. Of the two operations, the inguinal is to be preferred on account of the difficulties of the lumbar operation, from the smallness of the space between the last rib and the crest of the ilium, and from the fact that the descending colon is in these cases often displaced or not developed. If the lumbar operation is decided upon, it would seem to be better to perform it on the right side. The operation is necessarily followed by a

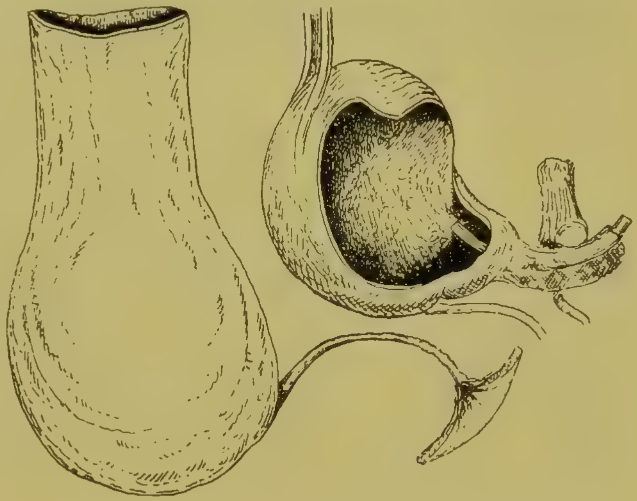

Fig. 350.—Figure showing the termination of the rectum in a blind pouch the size of a goose's egg. (From the Museum of St. George's Hospital.)

very high mortality, and children who survive the direct effects of the operation usually die early of some intercurrent malady.

4. Not infrequently the anus is undeveloped, and the lower end of the rectum opens into the vagina in the female, or into the urethra or bladder in the male, owing to failure in development of the perineal septum. The most common form is where the rectum opens into the vagina in the female. In these cases the opening is in the posterior wall, just above the orifice of the vagina. There is no obstruction to the evacuation of the fæces, but they pass through the vaginal outlet. Under these circumstances it is better to delay operative interference until the child is older, when the bowel may be opened in the perineum and an attempt made to close the vaginal opening. When the communication is with the urethra in the male, an opening should be made into the gut from the perineum, and the edges of the incision in the gut stitched to the external wound, in the hope that after a time the passage into the urethra may close, as sometimes happens. When the rectum opens into the bladder there is no resource but colotomy, and under these circumstances an inguinal colotomy should be done and a good spur formed, so that no fæcal matter may find its way into the lower part of the tube.

RECTAL FISTULÆ

Fistulous communications may occasionally be formed between the bladder and rectum, or the vagina and rectum.

Recto-vesical fistulæ.—Fistulous communications between the bladder and rectum may be produced (*a*) by cancer of the rectum ulcerating its way through into the bladder; (*b*) by wounds of the rectum in the lateral operation of lithotomy; or (*c*) by tuberculous or gonorrhœal abscess of the prostate, or the vesiculæ seminales bursting into the rectum and bladder. In the cancerous ulceration, the fæcal matter generally finds its way into the bladder from the rectum, and causes the patient the greatest distress and pain in its passage along the urethra; in traumatic cases, and in fistulous communications formed by abscess of the prostate, the contents of the bladder usually escape into the rectum, and, after collecting there for some time, are passed per anum.

Treatment.—In traumatic cases an attempt should be made to close the fistula by a plastic operation, but it is not often successful. In the fistulæ arising from cancerous ulceration of the rectum, nothing can be done locally, but great relief can be given to the patient by an inguinal colotomy. (See Cancer of the Rectum.)

Recto-vaginal fistulæ.—A fistulous communication may be established between the rectum and vagina as the result of sloughing, from the pressure of the child's head during parturition, or from syphilitic ulceration of the rectum. In the first class of cases an effort should be made to close the opening by a plastic operation, after division of the sphincter ani muscle. In recto-vaginal fistula in syphilitic disease, there is stricture as well, and a plastic operation is not likely to succeed. Under these circumstances an inguinal colotomy may be indicated. (See Syphilitic Disease of Rectum.)

INFLAMMATION OF THE RECTUM

Inflammation of the rectum (*proctitis*) may be a simple catarrhal inflammation, or may be septic, from the infection of gonorrhœa. The catarrhal form may arise from several causes: from large accumulations of fæcal matter; from the presence of foreign bodies; from the irritation due to new growths; and in children, from the presence of threadworms (*Oxyuris vermicularis*). To a considerable extent the symptoms resemble those of dysentery, but there is an absence of the constitutional disturbance and abdominal pain of this disease.

The **symptoms** are a sense of heat and pain about the rectum, constant tenesmus, and the passage of blood and mucus, with irritability of the bladder and frequent desire to pass water. In some cases where the swelling of the mucous membrane is great, there is a tendency to prolapse.

Treatment.—The treatment consists in confining the patient to bed and restricting him to a fluid diet, which leaves little solid residue. The bowels should be kept relaxed, and nothing is better for this purpose than a teaspoonful of castor oil every morning. For patients who cannot take this, one of the mineral waters may be substituted.

The local treatment consists in removal of the cause. The introduction of a suppository composed of iodoform, to which a small quantity of belladonna is added, is often beneficial.

Gonorrhœal proctitis is usually the result of the inoculation from the gonorrhœal discharge from the organs of generation in the female, but may be produced by direct infection. In these cases the mucous membrane becomes greatly swollen and prolapsed. There is intense burning pain, which during defæcation is almost unbearable, and profuse purulent discharge. The treatment consists in hot baths, rest in bed in the recumbent position, low diet, and saline purgatives. The pain may be relieved by the injection of laudanum in starch water; when the acute symptoms have passed off, the injection of a solution of nitrate of silver (two or three grains to the ounce) will usually cause the discharge to cease, and effect a cure.

Periproctitis.—By the term *periproctitis* is meant inflammation of the tissues outside the mucous membrane of the rectum, and these cases usually go on to the formation of abscess. The matter may be found in four different situations. (1) As a *marginal* abscess, situated in one of the cutaneous folds of the anus, superficial to the sphincter ani muscle. (2) As an *intermural* abscess, situated between the muscular and mucous coats, or in the substance of the muscular coat. (3) As a *peri-rectal* abscess, formed in the connective tissue immediately surrounding the rectum; and (4) as an *ischio-rectal* abscess, where the matter forms in the loose cellular tissue of the ischio-rectal fossa. This latter is the most common situation in which the disease occurs.

Causes.—The inflammation may arise from a variety of causes. (1) In a considerable number of cases it owes its origin to some abrasion of the mucous membrane of the rectum—e.g. from the perforation of a fish-bone—and through this abrasion the bacillus coli communis finds its way into the tissues outside the rectum and causes the inflammation. (2) In some cases the septic infection may arise from a little crack about the anus, caused by the passage of a constipated motion. (3) In other cases it may be caused by a blow or kick on the part; and (4) it may be induced by exposure to wet and cold, or even by sitting on the damp ground.

It may be acute or chronic.

In the **acute** form of the disease the patient is attacked with severe shooting or stabbing pain by the side of the rectum, which is greatly increased by defæcation or by digital examination. He is unable to bear the weight of his body in the sitting posture. There is usually a considerable amount of fever, and the temperature is raised to 102° or 103°. When the tissues in the ischio-rectal fossa are involved, there is a hard brawny swelling by the side of the anus, which is exquisitely tender to the touch, and the skin over it is red and œdematous. The swelling soon becomes soft and fluctuating. When the abscess is in the wall of the gut, there is not so much swelling in the ischio-rectal fossa, but on introducing the finger into the rectum a soft fluctuating tumour will be felt under the mucous membrane. If left to itself, the abscess may burst either internally into the gut, or externally, or most commonly in both directions, and may lead to the formation of a fistula in ano.

The **chronic** form usually occurs in tuberculous individuals, and is frequently a complication of phthisis. A deposit of tubercle takes place in the submucous tissue or in the tissues outside the rectum; this caseates and slowly forms an abscess, which is generally limited to one side of the bowel, but may denude it to a very considerable extent and may track up to a very long distance from the anus. The symptoms are those of a sense of uneasiness and weight about the lower end of the rectum, followed by the formation of a fluctuating swelling in the ischio-rectal fossa. It may be mistaken for abscess in other parts which has burrowed its way down into the ischio-rectal fossa, as in disease of the sacro-iliac joint; but the treatment is the same, and very often the diagnosis cannot be made until the abscess is opened. The treatment consists in laying the abscess open at the earliest possible period, scraping away all the tuberculous material with a sharp spoon, flushing the cavity out and packing it with iodoform gauze.

FISTULA IN ANO

A **fistula in ano** is a suppurating channel or sinus by the side of the rectum, arising from one of the varieties of abscess above described. They may be of two different kinds: (1) complete fistula, and (2) incomplete.

The **complete** fistula is a suppurating channel or sinus which has two openings, the upper one into the bowel, the lower one on the surface of the skin. The **incomplete** fistula is a suppurating channel or sinus where there is only one opening, and this opening may be either at its upper or lower end; that is to say, either opening into the bowel or on to the surface of the body. The former is termed a *blind internal* fistula, and the latter a *blind external* fistula. These fistulæ vary according to the variety of abscess which causes them. The marginal abscess usually produces a short suppurating track under the mucous membrane, generally not more than half an inch or three-quarters of an inch in length. It merely requires division of the mucous membrane over the track, and dressing the exposed surface, with iodoform, and it usually heals without difficulty. The intra-mural abscess rarely leads to fistula; if opened early from the surface the reparative process is not interfered with, not being influenced by the action of the sphincter muscle, and it heals as an abscess in any other situation. If, however, it is allowed to burst into the intestinal canal, it forms a fistula which may become complete or remain as a blind internal fistula, and will require division. The typical form of fistula is produced by the ischio-rectal abscess, which is prevented from healing either by small particles of fæcal matter finding their way into the abscess cavity and keeping up irritation, when there is an internal opening, or else by the constant contraction of the sphincter ani muscle, which keeps the walls of the abscess apart and in constant movement, and so prevents the rest necessary for repair from taking place. In its complete form the upper opening is generally very near the anus, just above the external sphincter, and the lower one is, as a rule, not far from the margin of the orifice; so that the fistula is not of any great length (fig. 351). But this is not always so. In some cases the internal opening may be high up, and in others the sinus may burrow round the bowel; and the external opening may be on one side, while the internal is on the other. In other cases a single opening in the bowel may communicate with two or more on the surface of the body, producing a Y-shaped fistula.

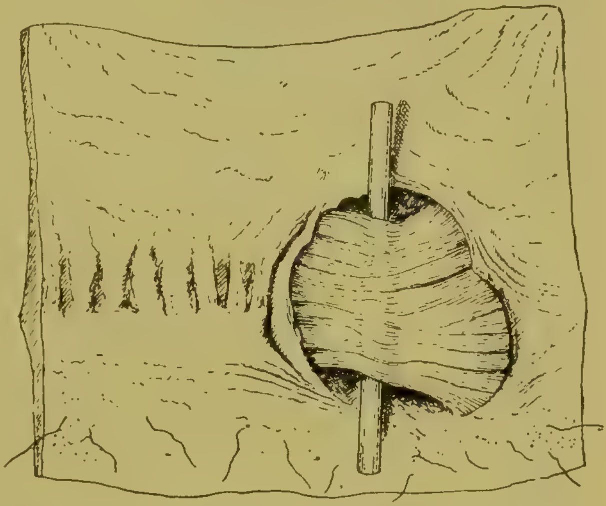

Fig. 351.—Drawing showing fistula in ano. The muscular fibres of the sphincter ani are dissected to show the relationship which they bear to the fistula. (From the Museum of St. George's Hospital.)

The **symptoms** of a complete fistula are self-evident; the presence of an orifice by the side of the anus, which often presents a minute vascular granulation and is constantly discharging a thin purulent fluid, marks the disease. But it must not be forgotten that fistulous openings in this situation may not originate in the rectum; they may be caused by a urinary abscess which has burrowed backwards, or by a labial abscess from gonorrhœal or fistulous channels in connection with disease in the pelvis; not, indeed, that a fistulous track in this situation is a simple fistula in ano, the result of an ischio-rectal abscess, for it may arise from stricture of the rectum, either simple or malignant. This point, however, will be ascertained when the finger is introduced into the rectum. The upper opening of a complete fistula in ano is not always easy to find, but it is of the greatest importance, as regards the treatment, that it should be found. Many of the cases of unsuccessful operation for fistula are due to the fact that the internal opening has escaped detection, and that the director has been pushed through some other part of the mucous surface, so that the whole length of the suppurating track has not been divided. The difficulty in finding the internal opening is explained by the accompanying diagram (fig. 352). In figure A, *a* is intended to represent an ischio-rectal abscess which communicates with the bowel at *b* and the surface of the body at *c*. When this abscess contracts into a sinus it assumes the shape shown in figure B, and the probe introduced at the external opening *c* naturally travels to the top of the sinus at *d*, and misses the internal opening *b*.

In order to find the internal opening, the finger, well oiled, should be introduced into the rectum. In old-standing cases a well-marked cordlike induration can usually be detected, and on tracing this upwards a depression will often be felt on the mucous surface, which marks the internal opening. A probe is now passed along the sinus without using any force, and is made by gentle pressure to find its way along the canal till it emerges at the depression which was felt by the finger. Too much care cannot be employed in conducting this examination, for it is easy to push the probe out of the sinus into the surrounding tissues, and then the subsequent operation will prove futile to effect a cure.

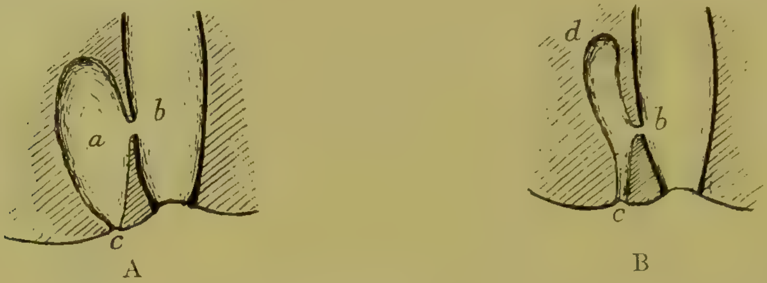

FIG. 352.—Diagram showing the formation of a fistula. *a*, abscess in ischio-rectal fossa; *b*, opening into gut; *c*, external opening; *d*, abscess contracting and forming a fistula.

Blind internal fistula is that form of fistula where the abscess has burst into the rectum, but has not burst externally. The symptoms are often somewhat obscure. The patient complains of a sensation of uneasiness and discomfort, especially after defæcation, and notices perhaps that there is an occasional discharge of pus from the bowel. Upon examination, a tender or brawny spot may sometimes be detected by the side of the anus, and on pressing on it, pus may be made to escape by the anus. Upon examination with the finger in the rectum the internal opening may be felt, or it may be seen through a speculum. In some cases a very characteristic train of symptoms may be set up. The patient complains of a gradually increasing sensation of pain and weight about the rectum, with the formation of a hard tender swelling near the anus. These symptoms go on increasing in severity from day to day, until they culminate in a fairly copious discharge of pus from the rectum, generally during defæcation, and an immediate cessation of the swelling and pain. After a time the symptoms recur and run a similar course.

The **blind external fistula** is not common; it usually results from blows or other injuries. It is recognised by the fact that the probe cannot be passed into the bowel; but care must be taken not to confound a complete fistula, in which the internal opening is not easy to find, with this form of fistula.

Treatment.—Operative interference is usually necessary for the cure of fistula; but there are some cases in which it would appear to be desirable not to attempt the cure, such as cases of fistula in ano dependent on a tuberculous condition, in which there is also an advanced tuberculous condition of the lungs—a not uncommon state of things. In these cases, if the operation is performed, probably the wound will not heal, and the patient's condition will be aggravated. In old people with fistula, when the condition causes little inconvenience, it is better also to abstain from operating.

Operation.—The usual mode of operating in these cases is to divide the tissues between the fistula and the bowel, and to dress the wound from the bottom. The patient, his rectum having been previously emptied by an enema, is placed in the lithotomy position, and the parts having been shaved and washed, a director is passed up the sinus until the point emerges in the rectum: along this a curved blunt-pointed bistoury is inserted until it meets the tip of the forefinger introduced into the bowel. The forefinger, steadying the blunt point of the bistoury, is then withdrawn together with the bistoury, and thus all the intervening tissues, including the sphincter, are divided. A careful search is now made for any secondary branching sinus; and such, if found, must be laid open and scraped. If the walls of the main sinus are much thickened, as is usually the case, they should be dissected away with scissors or a knife, and a clean raw surface left. If this is thoroughly done, the surfaces of the wound may now be brought together by sutures, and the convalescence materially hastened; but in most cases it is better to dust the wound with iodoform, and then pack it with gauze soaked in iodoform emulsion. The wound should be irrigated and repacked with fresh gauze every day, and the bowels kept confined for three or four days. Other plans of operating are by means of the elastic ligature, the galvano-cautery, and the écraseur. They are much inferior to the cutting operation.

In operating on an incomplete fistula, the first step of the operation is to convert it into a complete fistula. If the case is one of incomplete external fistula, the director is to be introduced as far as it will go, and it is then pushed through the intervening tissues into the rectum until it meets the finger introduced through the anus; the operation is then completed in the usual way. When the fistula is an incomplete internal one, a probe is bent into the form of an abrupt hook, and having been introduced into the rectum, the point is guided, either by the help of a speculum or by the finger introduced by its side, into the internal opening. It is then dragged down until the point can be felt presenting at the bottom of the fistula, under the skin by the side of the anus. The point is cut down upon with a scalpel, and a director passed through the wound thus formed into the bowel; and a bistoury carried along the director is made to cut its way out and complete the operation.

FISSURE

The so-called **fissure of the anus** is in reality a small ulcer, never much larger than a threepenny piece, which is usually situated between the folds of mucous membrane at the upper part of the anus, just above the ring of the external sphincter, and most commonly at the posterior part of the gut. Though pathologically a matter of insignificance, it is nevertheless of considerable practical importance, because it produces the greatest misery to the patient, and is often the means of seriously undermining his health.

Causes.—These ulcers are usually believed to be formed by some slight abrasion, possibly caused by the passage of a large and costive motion, or the result of dirt &c. In consequence of the constant action of the sphincter and the lodgment of particles of fæces in the basin of the ulcer, a continued irritation is kept up, and the sore is prevented from healing. Ball of Dublin believes, however, that they are formed in another way. At the point where the hind gut joins the involuted epiblast in the process of development, are to be seen a number of muco-cutaneous folds, called the *anal valves.* Ball believes that one of these folds is torn from its upper connections during the passage of a motion. At each subsequent motion, the little sore thus made is reopened and the fold is torn a little further down, until it appears at the anal orifice and constitutes the little tag of skin which is usually to be seen just outside the anus in these cases, indicating the position of the fissure, and sometimes known as the *sentinel pile.* In whichever of these two ways the fissure is formed, it will generally be found that they only occur in individuals who are debilitated or broken down in health. They are more common in women than in men, and especially women who are of weakly constitutions.

Symptoms.—The symptoms of this condition are very distressing and sufficiently characteristic. The patient complains of a severe, burning pain, either coming on during or shortly after the passage of a motion. The pain is situated within the anus, and usually radiates from this point down the thighs, and upwards to the sacro-iliac joint. It lasts for some time, and then somewhat suddenly disappears, only to return upon the next act of defæcation. The severe pain excited by the passage of a motion causes the patient to refrain from defæcating as long as possible, and sometimes from taking food. The constant pain and irritation, conjoined with the irregular action of the bowels and the insufficient food, causes the patient to become emaciated and debilitated; his countenance is pale, anxious, and careworn, and the nervous system generally sympathises with the local mischief. There is often very considerable irritation of the genito-urinary organs: in the male, constant desire to micturate, often without the ability to do so, and nocturnal emissions; in the female, symptoms of uterine irritation. Frequently a trace of blood or pus will be passed with the fæces. Upon examination, a small single tag of skin, the sentinel pile, will be seen; and on the under surface of this, the ulcer will be discovered looking like a little crack, until the anal folds are separated, when it will present the appearance of an excavated, ulcerated surface, with somewhat indurated edges. The examination is extremely painful, and the sphincter muscle will be found to be in a state of spasmodic contraction.

Treatment.—There are several ways in which these fissures of the anus may be treated. In the early stages, all that is often necessary is to improve the general health by change of air, tonics, and regulated diet; keep the bowels lax, so that the patient shall have no hard fæces to pass, by means of compound liquorice powder or sulphur lozenges, and apply an ointment of the grey oxide of mercury (ʒj to ℥j) before and after defæcation. If this does not effect a cure, the best plan of treatment is to divide the sphincter fibres forming the base of the ulcer, and so paralyse those fibres which, by their contraction, prevent the ulcer from healing. The operation can easily be performed by giving the patient an anæsthetic or destroying the sensibility of the part with cocaine, and then introducing the forefinger of the left hand into the rectum, passing a 'fissure knife'—a broad knife with a blunt point—along the finger, turning its cutting edge towards the ulcer, and dividing the tissues outwards through the base of the ulcer for the extent of about the eighth of an inch. No dressing is required, but the surface of the cut should be powdered with iodoform. Some surgeons prefer to forcibly stretch and paralyse the sphincter under an anæsthetic, and this plan of treatment is usually followed by cure. Ball recommends that the small pile at the lower end of the fissure should be removed by a V-shaped incision, and the ulcer scraped with a sharp spoon.

PILES OR HÆMORRHOIDS

Piles or **hæmorrhoids** are one of the most common and important diseases of the rectum, affecting almost all classes of the community, the rich and the poor, the sedentary and the active, the male and the female, and occurring at any period of adult life, though most commonly met with about middle life.

They consist of an increase and dilatation of the hæmorrhoidal vessels, especially the veins, with proliferation of the connective tissue. The superior hæmorrhoidal vessels are the ones principally affected, for these are the vessels which supply the greater part of the rectum. When the rectum is developed from the lower end of the hind gut, it descends into the pelvis and carries with it the terminal branch of the inferior mesenteric artery, the superior hæmorrhoidal, which therefore supplies the whole of that portion of the rectum which is developed in this way ; the middle and inferior hæmorrhoidal merely supplying the proctodæum, or that part of the lower end of the intestinal tube which is developed from the involution of epiblast. A free anastomosis takes place between these two sets of vessels. The arrangement of these vessels in the walls of the gut has a particular bearing on the causation of piles. The veins, which are the vessels principally implicated, form a circlet around the anal orifice ; in this plexus the veins are normally dilated, and from it are given off about six vessels, which ascend in the submucous coat parallel with each other for about three inches ; they then pierce the muscular coats, and are arranged circularly outside this coat on the wall of the gut, as they ascend to form the inferior mesenteric vein.

Causes.—The causes of piles are very numerous. There can be no doubt that one of the great predisposing causes is the erect position which is assumed by man, so that the blood in the hæmorrhoidal vessels is returned against the force of gravity ; for the disease is entirely unknown among quadrupeds. But there are also several other anatomical causes which predispose to the formation of piles, among the chief of which must be mentioned the manner in which the veins pierce the muscular coat and are therefore liable to be constricted during its contraction, and thus, the return of the venous blood being impeded, the tributaries forming these veins are apt to become dilated. Again, the veins, being situated in a stratum of loose connective tissue, lack that support which is afforded to most other veins, and this also predisposes to their dilatation ; and finally, the hæmorrhoidal veins are destitute of valves, and therefore the column of blood is not interrupted, but the force of gravity through the whole length of the vessel is brought to bear upon its most dependent part at the anus. In addition to these various anatomical causes, there must be taken into account the mechanical effect of defæcation. During the forced expiratory efforts employed to accomplish this object, the return of the venous blood is impeded, and the tributaries of the hæmorrhoidal veins become turgid with blood, and this is apt to lead to their permanent dilatation. A sedentary occupation, alcoholic excess, and constipation, by leading to congestion of the liver, must also be reckoned as predisposing causes of piles.

Classification and Pathology.—Hæmorrhoids are usually classified as external and internal: the former being situated outside the verge of the anus, and being covered by skin; the latter being within the gut and covered by mucous membrane. But in addition to these, there are a third group, which are situated partly within and partly without the anus, and are covered on one face by skin and on the other by mucous membrane. These are known as the *intero-external* or *marginal* piles. The internal structure of all is, however, the same; and except as regards their external covering, there is no essential difference in their structure.

Upon making a section of a pile, it presents a sponge-like appearance, being made up of a number of cysts, varying in size and covered by a smooth endothelial lining, similar to that found in blood-vessels. These are the dilated veins. They are bound together by a varying amount of connective tissue, in which moderately large arteries ramify. In the external pile there may be simply one large cyst, which is the varicose vein, surrounded by a considerable development of subcutaneous fibro-areolar tissue; and occasionally the cyst may be filled with clotted blood when the pile has become thrombosed.

External piles form defined tumours which surround the anus. They are, under ordinary circumstances, soft, easily compressible, and can be emptied of their contents. They vary in size, and are generally, from thinning of the skin over them, of a purplish hue. During straining they become enlarged and tense. They usually cause little inconvenience. There may be a sense of pain during defæcation, and a feeling of weight, fullness and discomfort afterwards, and probably a sensation of moisture about the part. But beyond this, the patient is hardly conscious that anything is wrong, until the pile suddenly becomes thrombosed. This is believed to be due to a phlebitis set up by the presence of the bacillus coli communis, which has effected an entrance into the pile through an abrasion produced by the passage of a hard motion, or some such cause. Then acute symptoms are set up, and the patient is said to have an 'attack of the piles.' The tumour becomes hard and exquisitely tender, and the parts around red, hot, swollen, and œdematous. Great pain is complained of, and the patient is unable to assume the sitting posture, and the act of defæcation is indescribably painful. There is considerable fever and malaise, pain in the back, a raised temperature, and a furred tongue. If the condition is allowed to go on, the inflammation terminates very often in suppuration; the abscess points and bursts, giving exit to broken-down blood clot, and an immediate relief to the symptoms, and a spontaneous cure of the pile. It may, however, leave a marginal fistula behind.

Treatment.—By far the most efficient way of treating these cases is to give the patient gas, or cocainise the part, and make an incision into the pile and turn out the clot, upon the appearance of the signs enumerated above. This will be at once followed by a relief from the pain, and a subsidence of the other symptoms. The little cavity will speedily heal up from the bottom, and the pile will be permanently cured, a little fringe or tag of skin being merely left to denote its original site. If the patient object to this slight operation he should be confined to bed, on a light unstimulating diet; a gentle laxative should be given, and hot fomentations applied to the part. A good plan is to smear the pile with equal parts of extract of belladonna and glycerine, and then apply a hot fomentation. In the course of a few days the inflammation will either subside, leaving a thickened mass of tissue, which may again become inflamed at a later date; or suppuration may occur, when the pile will be permanently cured.

Internal piles (fig. 353) are situated within the verge of the anus, and are covered with mucous membrane. They present the appearance of fleshy masses, with a broad base, of a dark reddish or purplish colour, which may at times be seen protruding from the anal orifice. They are sometimes ulcerated on their surface.

Symptoms.—The most important, because the most frequent and often alarming symptom, is bleeding during or after defæcation, so that the terms *bleeding* and *internal* piles are regarded as almost synonymous. The bleeding is at first induced by the passage of the hardened motion over the vascular mucous membrane, but after a time it occurs independently of defæcation, and may often amount to a very considerable loss. There is pain, not very great unless the pile becomes strangulated, and consisting more of an uneasy sensation, as of the presence of some foreign body in the rectum, than actual pain. There is, also, often an aching, reflex pain in the back. Tenesmus is sometimes present, and a glairy mucous discharge. During the act of defæcation the pile or piles are often extruded from the anus; they are then tightly nipped by the sphincter and become strangulated; the pain becomes very severe, but is relieved by reducing the pile. In some cases the strangulation may be so complete that the pile sloughs, and in this way a spontaneous cure may be brought about, though usually it is incomplete, only a portion of the pile being destroyed. In other cases inflammation may be set up in the pile, from some abrasion permitting the entrance of the bacillus coli communis, and in these cases a spontaneous cure may result.

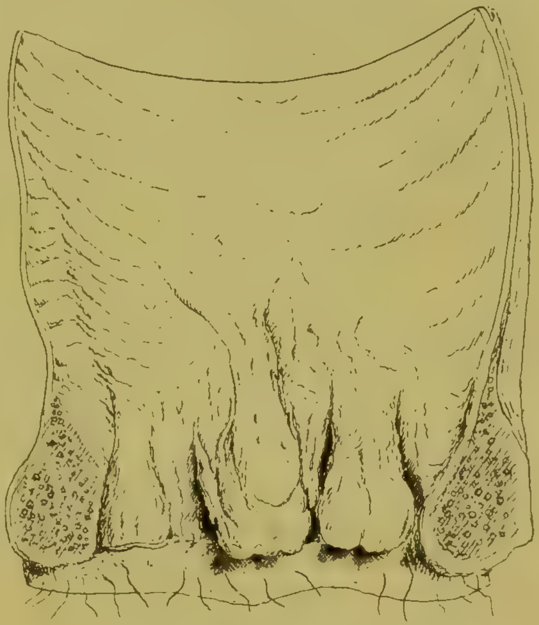
FIG. 353.—Internal piles.
(From the Museum of St. George's Hospital.)

Treatment.—The treatment of internal piles may be either palliative or curative. It is not every case of internal piles which requires operation, and in many, by palliative treatment, a complete relief from the trouble may be obtained.

The palliative treatment consists in the first instance in ascertaining and removing, if possible, any cause which has given rise to the piles. If there is any hepatic obstruction or fæcal accumulation it must be overcome, and in every case the bowels must be carefully regulated, so that the piles shall not be excoriated by any hard motion; sulphur, cascara, sulphate of magnesia, or one of the natural aperient waters should be given in sufficient quantities to ensure a soft motion every day, without purging. The patient should be instructed after each action of the bowels to lie down for half an hour, with the pelvis raised so as to relieve congestion from gravitation. A most excellent plan, from which I have found the greatest benefit, is to get the patient to endeavour to educate his bowels to act last thing at night, before he retires to rest. As soon as they have acted, he assumes the horizontal position, and may in this way entirely rid himself of all his distressing symptoms. The diet must be carefully regulated, and the food consist of easily digestible articles, and all excess of wine or spirits avoided. Daily exercise in the open air should be enjoined. As regards the local treatment, the parts should be well sponged night and morning, and after each action of the bowels, with cold water. Various astringents and anodynes may be used, of which perhaps there is none so useful as Ball's ointment:

Morph. acetat.	gr. v
Tannin., ext. bellad.	āā ʒss
Vaselin., lanolin.	āā ℥ss

Others which may be used are the compound gall and opium ointment; extract of hamamelis; or an injection of a drachm of hazeline in an ounce of water may be thrown in the rectum after the bowels have acted.

Curative treatment.—When the palliative treatment above indicated is not sufficient, and especially in cases where there is much hæmorrhage or great tendency to prolapse during defæcation, operative interference is generally required, unless the patient's state of health contra-indicates it, or there is cirrhosis of the liver, under which circumstance no operation would be advisable. Many different plans have been advocated and adopted for the operative treatment of internal piles, such as (1) their destruction by nitric acid or other caustics; (2) electrolysis; (3) injection of carbolic acid, perchloride of iron, or other coagulants; (4) crushing; (5) the actual cautery; (6) ligature; and (7) excision of the pile-bearing area of mucous membrane.

Of these various operations, probably the best and the ones most usually employed are the application of nitric acid or electrolysis in cases of small vascular piles; ligature, where there are large isolated piles; and excision of the pile-bearing area where there is a diseased condition of the entire plexus of veins at the lower end of the rectum. These three operations will therefore be described, and only a brief allusion made to other plans.

The **treatment by electrolysis** is for some reasons to be preferred to the application of nitric acid, and especially because it does not necessitate an anæsthetic, nor confinement to bed afterwards. It is performed by introducing three, four, or more needles connected with the negative pole of a continuous current battery into the pile, and then applying a sponge connected with the positive pole to the skin in the neighbourhood of the anus. Too strong a current is not desirable; from ten to fifteen cells of a Leclanché's battery are sufficient. Bubbles of hydrogen will be seen to escape by the sides of the needles, and in the course of a few minutes the pile will become white. The needles are then withdrawn, and a little iodoform is sprinkled over the part. In a few days the piles shrivel up and disappear.

Treatment by ligature.—The patient's lower bowel having been emptied shortly before the operation by an enema, he is anæsthetised and placed in the lithotomy position, or on his side across the bed, with the knees well drawn up. The two index fingers are then introduced into the bowel and gradually separated as far as possible; this will stretch the sphincter, and in the course of a minute or two paralyse it, and thus freely expose the lower end of the canal and cause the piles to prolapse. Stretching of the sphincter possesses also this additional advantage, that it materially diminishes the after-pain of the operation, which, if this is not done, is sometimes extremely severe, and is due in a great measure to spasm of the sphincter muscle. When the piles are brought into view they are to be seized with ring or catch forceps, and each one in succession is to be brought down and held by an assistant, while the mucous membrane or muco-cutaneous surface is divided at the lower attachment of the pile. This is not attended with much bleeding, as the vessels enter the pile from above. As soon as a deep groove has been thus formed, the pile is encircled with a ligature, which is carried into the groove and tied as tightly as possible, so as to entirely strangle the pile. The portion of the tumour in front of the ligature is now removed, taking care to leave enough to prevent slipping, and the ligature cut off short. Each pile is treated in this way until all have been removed; the parts are then dusted with iodoform, a morphia suppository (gr. ½) introduced into the rectum, and an antiseptic pad and T bandage applied. The bandage should be tightly fixed, as the pressure of it assists in relieving the after-pain.

Excision of the pile area.—This operation is recommended by Whitehead, and is applicable to those cases where the whole of the plexus of veins at the lower end of the rectum is involved in the disease. It is a severe operation, but possesses this decided advantage, that the whole of the affected mucous membrane, with the diseased veins, are removed, and therefore all liability to recurrence is prevented. The patient is placed in the lithotomy position, and the sphincter ani having been stretched, the mucous membrane is divided from the skin throughout the entire circumference of the bowel. The mucous membrane, with the attached vessels, is then separated from the muscular coat by tearing through the submucous tissue with some blunt instrument, as an elevator; any vessels which are wounded being at once seized with clip forceps. The separated mucous membrane is now drawn down, and divided transversely above the pile-bearing area. This is to be done gradually. Commencing below, a small portion is divided, and then the severed upper end is attached by a chromic catgut suture to the external skin wound. In this way successive portions are cut through, and each divided part is at once attached to the skin below. When the whole of the pile-bearing area has been separated and all the sutures applied, the parts are dusted with iodoform, a morphia suppository is introduced, and an antiseptic pad applied. The bowels are acted upon on the fourth day, and union is generally complete by the tenth.

Injection by carbolic acid is recommended by some. Three or four drops of a solution consisting of twelve grains of carbolic acid in a drachm of glycerine and a drachm of water are injected into the pile with a hypodermic syringe. The operation requires to be frequently repeated, and is not always successful.

Crushing consists in seizing the pile with a powerful clamp, which is allowed to remain on for a couple of minutes; the portion of pile projecting beyond the clamp is then cut off. The results in some cases are satisfactory, but there appears to be risk from hæmorrhage.

Cautery.—This consists in seizing the pile in a clamp, cutting it off, and searing the pedicle left with a cautery at a dull red heat.

The **after treatment** consists in giving opium if pain is severe; this also has the effect of keeping the bowels quiet. An aperient may be given on the fourth day. The parts should be daily bathed with some antiseptic lotion, and iodoform applied. The only complication which at all frequently arises is retention of urine, which may require the use of a catheter for a few days. The ligatures usually separate in about a week or ten days.

PROLAPSE OF THE RECTUM

Prolapse of the rectum (*prolapsus ani*) is a term applied to a protrusion of the rectal wall through the anal orifice. It may be partial, where there is a protrusion of the mucous membrane; and complete, where the whole thickness of the intestinal wall is extruded.

Causes.—Prolapse of the rectum may arise from a variety of causes: (1) from violent and long-continued straining, such as occurs in cases of stone in the bladder, or stricture, or phimosis in children, or enlarged prostate in old age, especially if these conditions occur in weakly persons, where the muscles about the anus are in a weak and relaxed condition; (2) polypoid or hæmorrhoidal tumours of the rectum very frequently produce a certain amount of protrusion of the mucous membrane; (3) inflammatory conditions of the rectum cause the mucous membrane to become swollen by exudation into its structure, and under these circumstances it is liable to become prolapsed; (4) any irritation, such as worms or diarrhœa in children, which leads to tenesmus and violent straining, is apt to occasion prolapse of the mucous membrane. The complete prolapse is commonly a more advanced stage of the partial condition. That is to say, after the partial condition has existed for a time, as more and more mucous membrane is prolapsed, it has a tendency to pull down the other coats and convert the condition into one of complete prolapse. The disease is principally met with in children and the aged. In children the disease rarely extends beyond the partial condition; whereas in the aged the complete form of the disease is not uncommon.

Symptoms.—Partial prolapse consists of a protrusion of mucous membrane, of a red or purplish colour, which is thrown into folds by sulci or pleats radiating from the anal orifice. The mucous membrane forming this ring is continuous with the skin at the margin of the anus. It at first is only to be seen immediately after the act of defæcation, and can be readily returned; later on it comes down independently of defæcation, and if allowed to remain down becomes swollen and infiltrated, and then the reduction is attended with difficulty. Strangulation may occur in cases where the prolapse is allowed to remain down for a considerable period of time, and in some cases it has sloughed off and a natural cure resulted.

Complete prolapse.—When complete prolapse occurs and the whole of the coats of the rectum are involved, the protrusion is larger and in some cases attains very considerable dimensions. These cases may be recognised by the fact that the sulci or grooves have a transverse direction, at right angles to the long axis of the gut (fig. 354). When the protrusion is considerable, the serous lining accompanies the tumour. This is most often on the anterior aspect of the tumour, as the peritoneum descends lower on this surface of the rectum than elsewhere; but in some cases a pouch of peritoneum may be formed all round, and into this a coil of small intestine may descend and even become strangulated.

The **diagnosis** of this disease is easy. The only condition with which it is likely to be confounded is intussusception where the intussusceptum protrudes from the anus; but the diagnosis ought not to be difficult, for the mucous membrane covering the intussusceptum is not continuous with the skin at the anal margin, and the finger can be introduced by the side of it into the rectum.

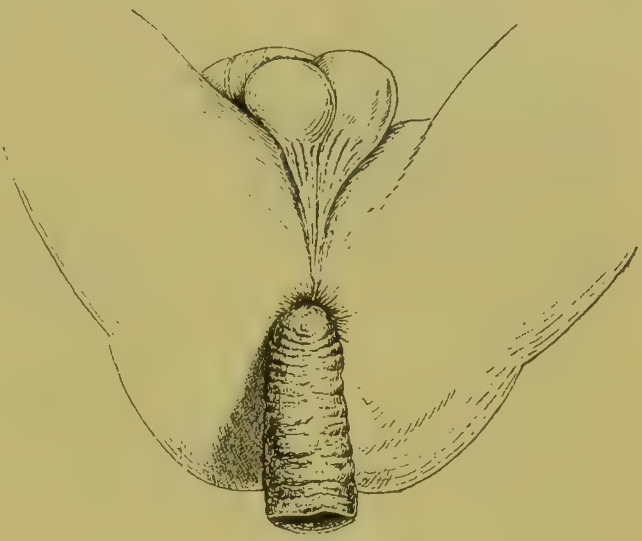
FIG. 354.—Complete prolapsus ani.

Treatment.—The first point to consider in the treatment of prolapsus is its reduction. This can generally be done by seizing the tumour and diminishing its bulk by steady pressure, and then gradually pushing it back, the central parts first. To prevent its return, the two nates should be strapped together by a broad strip of plaister. Any cause which has produced the condition must be removed: when there is a stone in the bladder it must be extracted; when there is phimosis, circumcision must be performed; when there are piles or a polypus, they must be removed; when there are thread worms in the rectum, they must be got rid of. After the cause has been removed, if the patient is a child, it should be taught to pass its motions lying on its back into a slipper or bed pan. The act of defæcation should never be performed in the ordinary sitting posture. If this is strictly attended to, no further treatment will probably be necessary. If the prolapse is never allowed to come down, and it will not come down in the earlier stages if the child defæcates in this position, the parts will recover their tone and a cure will be effected. Sometimes astringent injections are recommended: decoction of oak bark, solution of sulphate of iron (gr. iij to ℥i), or solution of alum.

In the adult generally, and in some cases of long-standing prolapse in children, operative measures may be necessary. The simplest and best plan is to cauterise the mucous membrane in a longitudinal direction. The prolapse is reduced; a speculum with a gap extending its whole length is introduced, so that the gap exposes a longitudinal strip of mucous membrane, at least three inches in length. A cautery iron, with a point at right angles to the rest of the shank, heated to a dull red heat, is now introduced into the speculum and the point carried along the exposed mucous surface for the whole length of the gap to the point where the true skin joins the mucous membrane. The speculum is now made to revolve a quarter of a circle and the process repeated, and so on until four of these linear eschars have been made. Iodoform is then insufflated over the charred surfaces, and the patient kept in bed. His bowels may be made to act upon the fourth day, but the motions are to be passed in the recumbent position for three weeks or a month, until the parts are firmly cicatrised.

In very large and irreducible prolapse amputation is indicated. The protrusion is divided close to the anus; all bleeding points secured as divided: the two peritoneal surfaces which are in apposition are then united by a continuous suture, and the lower cut end of the bowel united to the skin at the anal orifice. The objection to this operation is that the patient, at all events for some considerable time, has no control over his bowels, and a fresh prolapse may occur. The patient should therefore be enjoined to pass his motions into a bed pan. In some cases of inveterate prolapse, the abdomen has been opened and the rectum drawn up to its fullest extent, and attached to the abdominal wall by sutures passed through the meso-rectum.

Pruritus ani is a most distressing and intolerable itching about the anus, generally occurring at night and preventing rest, and rendering the patient's life miserable. It may occur from several causes; in a considerable number of cases it is due to eczema or some other eruption; in others it is due to pediculi or scabies, or to thread worms in the rectum; in others habitual constipation appears to be the cause, and it has been suggested that it is due to the absorption of poisonous products from the gastro-intestinal tract circulating in the blood; and finally in a certain number of cases it is believed to be due to a true neurosis of the rectum, not dependent on any systemic or local inflammatory trouble.

The **treatment** must have special reference to the cause. If it is due to eczema, the local application of preparations of tar, and if there are any gouty symptoms, the treatment of these is indicated. If there is habitual constipation, the constant use of saline aperient waters is to be recommended. In those cases where the disease has a neurotic origin, the treatment is very difficult. The local application of cocaine gives relief; or morphia and oleate of mercury. In some cases I have found great benefit from a lotion consisting of hydrocyanic acid, calamine, and glycerine in water. Internally phenacetin or antipyrin appears to do good in some cases; in others a course of arsenic is beneficial.

INNOCENT TUMOURS OF THE RECTUM

Innocent or **benign tumours** of the rectum are usually known by the name of *polypus of the rectum*, because almost all of these tumours have a tendency to become more or less pedunculated. The principal are (1) the adenoma, (2) the fibroma, and (3) the papilloma.

1. The **adenoma** is perhaps the most common, and is especially found in young children, though it may occur at any age. Its structure is that of a tubular adenoma, and consists of elongated and hypertrophied follicles of Lieberkühn, connected together by muscular and fibrous elements, covered by mucous membrane. It resembles in appearance a raspberry, being of a deep red colour, and usually finely lobulated on its surface (fig. 355). The pedicle by which it is attached to the gut is sometimes an inch or more in length. It seldom gives much pain unless it is situated so low down that it protrudes from the anus

during defæcation, and is nipped by the sphincter. The principal symptom is hæmorrhage; indeed, repeated hæmorrhage at stool in a young child is in the majority of cases due to the presence of a polypus. In some cases it may give rise to a certain amount of tenesmus and discharge of mucus. The diagnosis is verified by digital examination, but an enema should always be given before the examination is made, so as to bring the polypus down; otherwise it may escape detection. They are to be treated by dilating the sphincter, seizing the polypus and drawing it down, tying the pedicle and cutting it off.

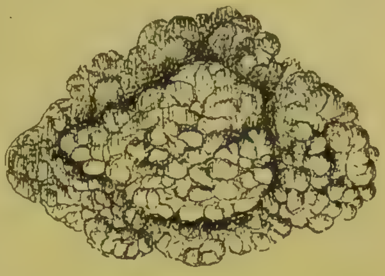

FIG. 355.—Adenoma of the rectum. (From the Museum of St. George's Hospital.)

2. **Fibroma.**—Tumours of connective tissue are sometimes found in the rectum. They are believed by Ball to take their origin from internal piles, which undergo fibroid changes and become pedunculated. They are to be treated by ligature and removal.

3. **Papilloma,** or **villous growth** of the rectum.—This rare form of tumour of the rectum resembles villous growth of the bladder, and consists of a number of somewhat club-shaped processes springing from a common base, and composed of a loop of blood-vessel in a matrix of connective tissue, covered by columnar epithelium. It is of slow growth, gives rise to considerable loss of blood, and often causes pain from its protrusion while at stool. The treatment consists in ligaturing the base, which is sometimes pedunculated, and cutting away the growth.

STRICTURE OF THE RECTUM

Stricture of the rectum is due to a contraction of the calibre of the bowel from structural changes in its walls or in the tissues surrounding it. It must be distinguished from those cases where the lumen of the tube is obstructed by some new growth.

Stricture of the rectum may be fibrous; may be due to syphilitic disease; or may be malignant.

Fibrous stricture of the rectum consists in a thickening and blending together of the coats of the bowel at the site of the stricture, as the result of the formation of a new fibroid or scar tissue, the result of inflammation. The stricture may be annular or tubular, according to the amount of bowel involved, but there is no arbitrary division between the two. They may be situated at any part of the tube; at the junction of the anus and rectum; very commonly two or three inches from the anus, or at the upper part of the rectum at its junction with the sigmoid flexure.

Causes.—Any destruction of tissue, the result of injury or ulceration, may give rise to fibrous stricture. Thus it may result from the removal of an excessive amount of skin or mucous membrane in the operations for piles or prolapsus; or it may follow the healing of ulcers, whether simple or dysenteric, syphilitic or tuberculous. It may also occur from infiltration of the coats of the rectum with inflammatory products, when there has been no ulceration, as in proctitis, especially the gonorrhœal form; or, finally, it may be caused by inflammatory thickening outside the gut, as in cases of pelvic cellulitis after labour.

The bowel above the stricture becomes distended; its muscular coat becomes hypertrophied, and the mucous membrane in the majority of cases ulcerated. Perforation may ensue, either into the peritoneal cavity, causing fatal peritonitis, or into the bladder or vagina, setting up recto-vesical or recto-vaginal fistula.

Symptoms.—The symptoms of non-malignant stricture are often, in the early stages, very obscure. There is usually constipation and straining in defæcation; or in many cases constipation alternating with diarrhœa; the diarrhœa being caused by catarrhal inflammation, set up by retained fæces. The motions are usually pellet-shaped or tape-like, but this must not be regarded as a characteristic symptom, as such a condition is often present where there is no stricture, and in those cases where the stricture is high up a well-formed motion may be passed, because the fæcal mass has time to form after it has passed through the stenosed portion of gut. In those cases where the stricture is low down and within reach of the finger, the diagnosis is at once made by digital examination. In the annular form of stricture, which is the more common, a hard ridge will be felt, generally encircling the whole circumference of the bowel, with or without ulceration below. If ulceration is present, there will be no great amount of induration. In the tubular form of stricture there will be felt to be a smooth, regular constriction of the gut, generally with a more or less ulcerated surface, but without any great amount of new formation of tissue. When the stricture is beyond the reach of the finger, a very characteristic dilatation or 'ballooning' of the rectum may be felt. This is believed by Mr. Bryant, who first described it, to be due to atrophy of the muscular coat, in consequence of arrest of peristalsis at the seat of the stricture, and to distension of the atrophied bowel by retained fæces. The introduction of a long tube has been recommended, as an aid to diagnosis, but it is deceptive, and is not altogether devoid of danger.

Where the stricture is inaccessible to the finger the **diagnosis** must be based on the history of former ulceration, with the passage of blood and mucus; on the constipation, or constipation alternating with diarrhœa; and on the presence of dyspeptic symptoms with flatulent distension.

Fibrous stricture may terminate by causing complete occlusion, which may come on either slowly or suddenly, or by perforative peritonitis. In other cases abscess may form above the stricture, which may burst into the bladder or vagina, and the patient may succumb to exhaustion.

Treatment.—In the early stages the treatment consists in keeping the bowels open and the motions soft by means of laxatives. A small dose of castor oil, which can be taken in a capsule, every morning is an efficient way of doing this; or some preparation of sulphur, either in the form of compound liquorice powder or sulphur lozenges, may be given; or one of the mineral waters. The diet must be carefully regulated, and no indigestible food taken, and the strength maintained by tonics. If the stricture is an annular one, and is within reach of the finger, treatment can be successfully carried out by gradual dilatation. A soft slightly conical bougie should be introduced through the stricture every day, and, if the patient can bear it, should be left in for an hour. The greatest care must be observed in passing the bougie through the stricture, as it is liable to be caught in the folds of the mucous membrane, and if any force is used a tear may result. The treatment should be commenced with a bougie which will pass through the stricture with a moderate amount of pressure, and a larger size may be introduced every third or fourth day. In this way the stricture may be gradually dilated up to the largest sized bougie, and great relief given; but it will be necessary to continue the occasional passage of the bougie, as there is great liability for recontraction to take place. In some cases where the contraction is very great, so as not to admit of the smallest sized bougie, a laminaria tent may be inserted, and when this has dilated the stricture somewhat the treatment by bougies commenced. Occasionally it happens that little dilatation can be effected by bougies, and then the operation of proctotomy must be performed.

Proctotomy.—This operation is performed by anæsthetising the patient and placing him in the lithotomy position. The point of the forefinger of the left hand is introduced into the stricture, and along this a blunt-pointed straight bistoury is passed; its cutting edge is directed backwards, and the stricture and coats of the gut are divided. By making the incision in the middle line there is no risk of wounding the peritoneum, and plugging will usually arrest all hæmorrhage. Some surgeons recommend notching the stricture in three or four places instead of freely dividing it behind. This operation will not cure the stricture; it will be certain to recur if left alone, and therefore the passage of a bougie must be rigidly enforced.

Where the stricture is tubular, treatment by dilatation appears to do little good, and division is rarely possible on account of the extent of bowel involved; when any indications of obstruction show themselves, a colotomy is the only means of saving the patient's life; and in those cases where the stricture is beyond the reach of the finger, the same measure must be adopted after palliative treatment has been persevered with as long as possible.

SYPHILITIC DISEASE OF THE RECTUM AND ANUS

A *primary chancre* is occasionally met with in the neighbourhood of the anus, and in the secondary stage of syphilis mucous tubercles or condylomata are very common; but when syphilitic disease of the rectum is spoken of, the term is intended to designate an extensive ulceration of the mucous membrane, which is usually regarded as a tertiary affection, and is believed to be due to the breaking down of gummatous infiltration of the submucous tissue of the rectum. There appear to be, however, many reasons which render this at least doubtful. The disease almost invariably attacks females, which is in itself a strange fact if we regard it as a tertiary affection, since men suffer from this as much, if not more, than women. Then again, it usually occurs before the age of thirty, which is young for tertiary syphilis. In many cases no history of syphilis or any other syphilitic manifestation can be obtained. In most if not all of these cases, the women affected are in the early stage robust and healthy, very unlike the victims of tertiary syphilis. It is true that later on they become worn out and emaciated, but this is due to the local disease, and not to any constitutional cachexia. Again, iodide of potassium, alone or combined with mercury, which is so potent for good in tertiary syphilis, is apparently absolutely useless in arresting the ravages of this disease. Finally, if the disease is cured, the patient entirely recovers, and becomes strong, healthy, and plump, and shows no further indications of developing tertiary symptoms.

Another view, which was first suggested by Gosselin, of Paris, seems to me to be a more probable one, namely, that it is a chancrous ulceration extending from the vagina, either by the discharge running down to the anus, or through menstruation, or it may be by direct contact from the male organ. If we adopt this view we at once explain why the disease occurs in women, and especially among the poorer classes, for it is among these that it is usually met with. These women are more apt to get sores about the genitals, and are probably not so careful when they do so as to cleanliness and treatment.

The disease, then, I believe, is a chancrous ulceration extending from the vagina, and its continuance and reluctancy to heal is due to the diseased surface being constantly irritated by the passage of fæces over it.

It is right to mention that we do undoubtedly occasionally meet with a true syphilitic disease of the rectum, which consists in the infiltration of the wall of the gut with a new formation, to which Fournier, who first described it, has given the name of *ano-rectal syphiloma*; but this is a very different condition from what is ordinarily described as syphilitic disease of the rectum. In these cases of true syphilitic disease there is no ulceration, and on introducing the finger into the bowel the mucous membrane is felt intact and apparently natural, but the other coats are thickened and indurated over a considerable area, and the calibre of the gut very materially diminished.

Symptoms.—Patients present themselves with the history that they have for some time experienced difficulty in defæcation, especially if the motions have been at all constipated, and that the act has been attended with great pain. Added to this there has been an abundant discharge of sanious, offensive pus, and it may be that the motions have been noticed to be tape-like or scybalous. Upon examination with the finger the lower part of the rectum will be found to be rough and honey-combed, and to bleed freely, the diseased portion often being surmounted by a contracted fibrous ring, where cicatrisation has taken place. The skin around the anus will be found to be hypertrophied, and often hangs down in loose folds or tags; frequently fistulous openings will be found, which lead up to the mucous surface above the stricture, and are caused by stercoral ulcers formed in this situation from the pressure of fæcal matter, which is unable to pass through the stenosed portion of gut. These ulcers spread and burst externally, or not infrequently into the vagina, forming a recto-vaginal fistula.

Treatment.—The treatment of this condition is often unsatisfactory. Iodide of potassium and mercury are recommended, but appear to do little good. The first thing is to dilate the stricture by the passage of bougies (see page 916). Some recommend smearing the bougie with blue ointment or oleate of mercury; for my own part I prefer iodoform ointment. The parts below the stricture should be daily irrigated with dilute Condy's fluid and iodoform dusted over the surface, or painted with Whitehead's varnish (page 662). If the bougie fails to dilate, linear proctotomy (page 917) should be performed. Under this treatment a certain number of cases may improve, but in many it fails to effect a cure, and after a time the general health begins to fail, the patient emaciates, and gets symptoms of chronic toxæmia. Under these circumstances an inguinal colotomy should be advised, and when performed the ulceration will rapidly heal under ordinary treatment, but the stricture will remain, and the lower part of the rectum will become contracted into a canal, which may probably barely admit a No. 12 catheter, so that the artificial anus will have to be retained for the rest of the patient's life.

CANCER OF THE RECTUM

Cancer of the rectum is a disease of common occurrence, and is an affection of middle life and advanced age, occurring more frequently in the male than in the female sex.

Pathology.—The form of cancer met with in the rectum is the columnar epithelioma. It consists essentially of closely packed masses of tubes, lined by columnar epithelium, resembling enlarged crypts of Lieberkühn, and inclosed in a cellular stroma, infiltrated with round cells, in which the vessels ramify. The structure varies according to the relative amount of cells and stroma. In the tuberous form the cells are greatly in preponderance, and the growth is very rapid. It appears as one or more nodules projecting into the bowel. It is soft and speedily ulcerates, and forms broken-down, crater-like cavities, into which the finger can be introduced (fig. 356). It rapidly extends to other structures, spreading to the tissues outside the bowel, and implicating the bladder in the male and the vagina in the female.

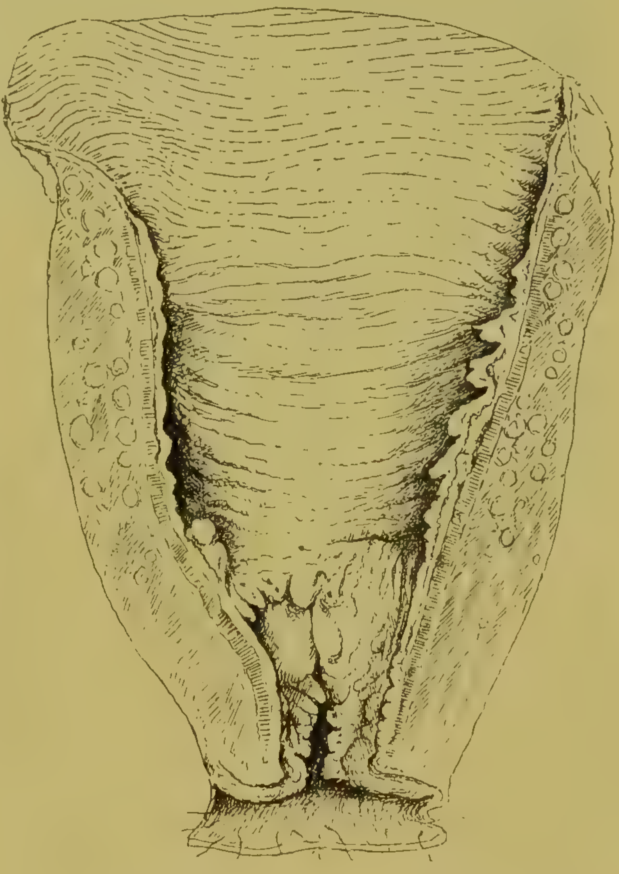

FIG. 356.—Cancer of the rectum. (From the Museum of St. George's Hospital.)

The other or annular form presents microscopically a greater amount of fibrous stroma, and a less amount of glandular element. It is much more chronic in its growth. It invades the submucous and muscular coats of the bowel, and following the course of the vessels it spreads circularly round the gut, so that it forms a ring which contracts and diminishes the lumen of the tube. To the finger it presents the sensation of a hard flat ring, infiltrating the coats of the bowel. In consequence of its hardness the term *scirrhus* is sometimes applied to this form of cancer of the rectum; but it must be distinctly understood that this does not imply that it is identical with scirrhous cancer elsewhere, as in the breast for example.

Symptoms.—The symptoms of the onset of cancer of the rectum are very insidious. There is a sense of uneasiness about the rectum and a feeling of want of relief after the bowels have acted, as if they had not been completely emptied. Then there is a tendency to diarrhœa, especially in the morning, with perhaps the passage of mucus and it may be a little blood. Pain in the back is another early symptom. As the disease advances and some obstruction takes place there is constipation, alternating with mucous diarrhœa; the passage of the fæces is partially arrested at the seat of the disease, and the retained motion decomposes and sets up a catarrhal proctitis, attended by the secretion of mucus, which is constantly being passed. After a time, in some cases the pain becomes very severe, in others it is slight. The degree of pain appears to depend in a measure upon the situation of the growth, being most severe in those cases where it is low down and the anus involved. It is also very severe in those cases where the growth extends backwards and involves the sacral plexus, and then often assumes the character of an intense sciatica. The amount of hæmorrhage varies; in the tuberous form it is sometimes considerable, while in the annular form it is usually slight. The blood is mixed with mucus and pus and is very offensive, constituting a foul, bloody discharge.

As the disease progresses, in the majority of cases, symptoms of obstruction come on; these may be very gradual, the descending colon becoming gradually distended and filled with fæcal matter, until at last complete obstruction takes place; but in some cases the obstruction may be more acute, owing to some impaction of a hardened mass of fæces, or some undigested portion of food in the narrowed portion of the gut.

Upon digital examination, if the disease can be reached by the finger, different conditions may be felt. In some cases a large irregular mass, soft and easily to be broken down by the finger, may be noted growing from one portion of the wall of the rectum, generally the posterior. This may sometimes be so large as to completely fill the tube and obstruct the passage of the fæces along it. It will be found to be extensively ulcerated, and to present to the finger large crater-like recesses or cavities, into which the finger can be introduced, and which are lined by broken-down material. In other cases a distinct hard and sometimes ulcerated ring of indurated tissue may be felt encircling the gut, and so contracting it that the point of the finger cannot be introduced through it. Between these two extreme conditions almost any intervening modification may be found.

As the disease progresses, the patient emaciates; the countenance becomes anxious; the spirits depressed; the digestion impaired. He is unable to sleep, and dreads the suffering entailed by the action of the bowels, and frequently dies of exhaustion, worn out by his sufferings. In other cases death may be induced by complete obstruction taking place, or in some cases perforation of the cancerous mass may occur into the peritoneal cavity, leading to fatal peritonitis.

Treatment.—The treatment of cancer may be palliative or curative.

1. The **palliative treatment** may consist simply in careful dieting, keeping the stricture dilated as much as possible, and relieving pain; or in the operation of colotomy. Much can be done to relieve a patient suffering from cancer of the rectum by careful dieting and medicines, and by the daily introduction of a bougie. The treatment consists in inserting a soft olivary bougie through the stricture daily, and allowing it to remain some

little time. This serves to keep the canal patent. It can, of course, only be done in those cases where the disease is within reach of the finger, and if done with care causes little pain. In addition to this a copious enema should be given occasionally to wash away any fæcal matter which may become lodged above the stricture. The diet must be plain and nutritious, and consist of such articles of food as leave little or no solid débris, and the patient should be cautioned that he must thoroughly masticate his food. Laxatives should be given as occasion requires, so that the motions should always be fluid or semi-solid. If there is pain, the local application of cocaine, or perhaps better eucaine, as it is not poisonous, is often attended with marked relief. By these means the patient's life may be rendered fairly comfortable, and obstruction may be warded off, at all events for a time.

Colotomy.—The operation of colotomy as a palliative measure is very variously estimated by different surgeons. There are some who recommend its performance as soon as the existence of the cancer is diagnosed, under the belief that it retards the rate of the growth of the cancer, because the fæcal matter no longer passing over the ulcerated surface, all irritation is removed ; and secondly, because it prevents obstruction ; and lastly, because it prevents pain during defæcation. Against these theories it must be stated that there is no proof that the life of the patient is actually prolonged by the operation, and in many cases no obstruction ever occurs. There is no question that in some cases the operation of colotomy is called for in cancer of the rectum, in cases where symptoms of obstruction of the bowels are present, and in cases where there is pain during the act of defæcation, but it would seem advisable to reserve its employment for these cases and not resort to it indiscriminately in every instance of cancer of the rectum ; for it cannot be denied that the operation is often attended with great distress to the patient, and there are many who regard their condition afterwards with intense horror and disgust, and frequently state that they would rather have died than go through what they have to with an artificial anus. Colotomy may be performed either by the inguinal or lumbar method.

Inguinal colotomy.—Inguinal colotomy has, in the present day, almost superseded the lumbar operation for the following reasons : (1) By the inguinal operation a more complete spur can be formed, and therefore no fæcal matter whatever is allowed to pass into the lower segment of the bowel, but is all discharged externally. In the lumbar operation, on account of the descending colon not being entirely invested by peritoneum, it is impossible to withdraw the whole lumen of the tube, and an opening can only be made on one side, and therefore the spur consists simply of a fold of mucous membrane, which is not efficient in preventing some of the fæcal matter finding its way into the lower bowel. (2) It is easier, there is more room, and the sigmoid flexure is more easily reached and identified, and no other portion of the intestinal tract is likely to be mistaken for it. Moreover, especially if the patient is stout, the anæsthetic is more easily administered and taken with the patient lying on his back than his side. (3) The peritoneum being opened, it is possible if thought desirable, by enlarging the opening, to introduce the hand into the pelvis and ascertain the exact extent of the disease, with a view to its removal. (4) The position of the artificial anus is more favourable as regards personal attention of the patient himself in cleansing, dressing, &c. The objections to inguinal colotomy which have been urged are : (1) That the peritoneal cavity is necessarily opened ; but with attention to antiseptic details this is a matter of little importance, and it must be borne in mind that the peritoneum is very frequently unintentionally opened in the lumbar operation under less advantageous circumstances. (2) That there is a greater tendency to prolapse of the gut. This no doubt is true, but it may be obviated to a great extent by attention to the details of the operation. (3) That there is risk of soiling the peritoneum if the operation is performed at one sitting; that is to say, if the contents of the bowel are at once evacuated before adhesions have formed. In the cases we are considering this is scarcely ever necessary; but when it is, by care and attention the risk is not a very great one.

The operation is performed as follows: The abdominal wall having been duly cleansed, an incision is made in the left inguinal region. It is usually recommended that this incision should be made at right angles to a line extending from the anterior superior spinous process to the umbilicus, the centre of the incision corresponding to the junction of the outer and middle thirds, and that it should be two and a half inches in length. Mr. Harrison Cripps, however, recommends that it should be made considerably higher, 'as high as the level of the umbilicus, so that the wall of the lower part of the abdomen, where the pressure is greatest, is left intact.' By this means he believes, with considerable justice, that he diminishes the tendency to prolapse. The layers of the abdominal wall having been divided, and the peritoneum opened and slit up to the extent of the external wound, a flat sponge with a cord attached is introduced to prevent any bulging of the intestine, and the cut edges of the peritoneum sutured to the skin by a continuous suture. The sponge being now withdrawn, the finger and thumb are introduced and a loop of sigmoid flexure pulled out of the wound. It is easily recognised by its appendices epiploicæ and its longitudinal bands. The bowel is drawn out of the wound and passed in again at its lower angle until no more will come. This is done that the opening may be made at the upper part of the sigmoid flexure in order to prevent prolapsus afterwards. The coil which now protrudes, and which should be withdrawn sufficiently to freely expose its mesentery, is fixed to the abdominal wall. Several plans are adopted for doing this. The method adopted by Mr. Herbert Allingham is simple and efficient. A needle threaded with carbolised silk is passed through the abdominal wall and parietal peritoneum on one side of the wound, then through the mesentery and through the parietal peritoneum and abdominal wall on the other side. The needle is then again introduced on the same side of the wound from which it emerged, at a distance of about half an inch from the point of emergence, and made to retrace its steps through the same structures. The two ends of the silk are then tied together, and in this way the mesentery is tightly embraced by the peritoneum covering the two edges of the wound. A few additional sutures are applied around the loop of gut, passing through the parietal peritoneum on the one side and through the peritoneal and muscular coats of the bowel on the other, but not being allowed to perforate the mucous membrane. Some operators pass a glass tube through the mesentery and allow it to rest on the skin across the wound; others simply attach the serous coat of the gut to the parietal peritoneum all round, without fixing the mesentery; and others make a hole in the mesentery and attach the two edges of the wound together through the hole. When all the sutures have been introduced, the protruding knuckle of intestine is covered by green protective, and the wound dressed in the ordinary way. On the third or fourth day the dressings are removed, and the protruding intestine, which will be now found to be covered with a layer of lymph, cut away with scissors. This is painless and does not require an anæsthetic, but the surgeon should be prepared with a number of artery clips, as there is sometimes fairly smart hæmorrhage. Should it be deemed necessary to open the bowels at once, the gut should be accurately sutured to the parietal peritoneum all round, and then, an opening into it having been made, a Paul's tube should be tied in (fig. 311, G).

Mr. Paul of Liverpool has suggested a modification of this operation, with a view to the prevention of the involuntary escape of the fæces, from the want of control of the orifice. It is framed on the principle of the modern operation of gastrostomy. An incision is made in the usual situation, the sigmoid flexure found and pulled out of the wound, and attached to its margins by one or two sutures only. It is then passed between the external and internal oblique muscles for about two inches, and finally brought to the surface through a second incision in the skin, opened and sutured; the original wound being completely closed. A truss, with a horse-shoe pad placed over the bowel as it runs in the abdominal wall, prevents the escape of any fæces as long as it is in position.

Lumbar colotomy may be performed in either flank, according as it is desired to open the ascending or descending colon. As a rule the left flank is selected, and the descending colon opened, as it is nearer the termination of the intestinal canal, and still, in most cases, sufficiently above the seat of the disease to fulfil all the requirements of the operation. Left lumbar colotomy is the operation which will here be described. The patient is turned well over to the right side, with a firm hard pillow under the abdomen, so as to arch up and render prominent the left flank. The parts having been properly cleansed, a straight line is drawn from the anterior superior to the posterior superior spine of the ilium, and a point taken half an inch behind the centre of this line. From this point a vertical line is drawn upwards to the last rib. This marks the course of the descending colon, and the central point of it between the crest of the ilium and the last rib marks the centre of the incision. An oblique incision is now made through this point, so that two inches are in front and two inches behind it. The incision is carried through the skin and superficial structures, and through the layers of the abdominal muscles, first dividing a part of the latissimus dorsi and external oblique; then through the fascia lumborum, and perhaps some of the posterior fibres of the internal oblique, and opening the sheath of the quadratus lumborum, the anterior border of which will probably also require division. The transversalis fascia, which is here very thin, is now to be opened to the whole extent of the incision. If the bowel is distended, it will bulge into the wound, and there will be no difficulty in dealing with it. If, however, the gut is empty, this bulging will not take place, and the colon will have to be sought for. Retractors are inserted into the lips of the wound, so as to stretch it wide open, and the fat carefully separated with the fingers in the direction of the colon. The guide to the colon is the lower edge of the kidney, and this having been defined, the bowel must be sought for immediately in front. If there is any difficulty in finding it, the patient may be rolled over on to his back, when the colon will descend into the wound; or, failing this, air may be injected into the rectum, if there is not such complete obstruction as would prevent its passing.

When the bowel has been found—and it may be recognised by the longitudinal bands of its muscular coat—the further steps of the operation will depend upon whether it is the intention of the surgeon to complete the operation at once and open the gut, or whether he proposes to defer opening the bowel until adhesions have formed. As nowadays the cases in which lumbar colotomy is performed are cases of urgent obstruction, the former of these two procedures is indicated, and this will first be described. The gut is pulled as far out of the wound as possible, packed all round with antiseptic pads; a small incision is then made, and a Paul's tube tied in. The patient is now turned on to his back and brought to the edge of the table, and the contents of the colon allowed to escape. When the gut has become flaccid and empty, it is attached to the external wound by a few sutures inserted round the tube, and the rest of the wound closed with silkworm gut or silver sutures. Gauze is applied over the wound around the tube, and an abundant supply of carded oakum or wood wool made to cover the whole, into which the discharge from the tube finds its way. The tube will separate in a few days, but by that time adhesions will have taken place, so that no harm will result from the fæces which will escape from the opening in the gut. If the patient is in a condition to permit of the operation being done in two stages, the plan advocated by Mr. Davies-Colley should be adopted. After the colon has been found and drawn up into the wound, two harelip pins are passed through the protruding piece of bowel at right angles to the wound; these are allowed to rest on the surface of the body, separated from the skin by a strip of gauze. The pins should be passed at such a distance from each other as to permit of an opening being made in the gut between them. The rest of the wound is then closed and dressed in the ordinary way. On the fourth or fifth day a small crucial opening is made in the colon between the pins.

2. The **curative treatment** of cancer of the rectum consists in excising the lower end of the rectum, with the growth, by an operation which is known under the name of *proctectomy*. The operation should only be attempted in those cases where it is possible to remove the whole of the growth.

There are two ways in which the operation may be performed: (1) through the perineum; and (2) by Kraske's operation or some modification of it.

The operation through the perineum.—The cases in which this operation can be performed are very few indeed. Before the surgeon attempts to remove the lower end of the rectum through the perineum, he should satisfy himself on the following points: (*a*) that the finger introduced into the rectum can reach well beyond the growth throughout the entire circumference of the bowel; (*b*) that the growth has not extended outside the coats of the bowel, and that it is freely movable on the bladder and prostate in front, and on the sacrum and coccyx behind; (*c*) that there is no reason to suspect any enlargement of the lumbar glands or secondary implication of the liver; (*d*) that the patient is in fairly good health and has not been worn out by the disease. The number of cases suitable for excision by this operation is therefore exceedingly small.

The operation is performed as follows: The patient is placed in the lithotomy position, and a finger being introduced into the rectum beyond the growth, a sharp-pointed curved bistoury is inserted along the finger, and the point made to enter the mucous membrane on the posterior wall of the gut above the growth and brought out at the tip of the coccyx. By causing the knife to cut its way out, the whole of the tissues, including the wall of the rectum in the middle line, are divided down to the coccyx. An incision is now made in the skin all round the opening of the anus, and the gut separated from the tissues in the ischio-rectal fossa. Posteriorly the separation can be performed rapidly and without difficulty by means of a director or the point of a pair of scissors, but in front the greatest care will have to be observed in separating the urethra and prostate gland in the male and the vagina in the female. The dissection is attended by considerable bleeding, and each wounded vessel must be seized with clip forceps as soon as it is divided. When the lower end of the rectum has been thus separated all round to above the level of the growth, it is to be cut off with scissors, the galvano-cautery, or the écraseur. In those cases where there is any difficulty in getting beyond the confines of the growth, more room may be obtained by separating the coccyx and last piece of the sacrum from surrounding structures, and then removing them with cutting bone forceps. No attempt should be made to bring down the cut end of the bowel and suture it to the skin, as it will not unite; the tension is so great that the stitches would certainly cut their way out very rapidly. As healing takes place, the mucous membrane becomes drawn down, and in some cases power of retention is obtained. After the operation is completed, the parts should be swabbed out with a solution of chloride of zinc (gr. xl to ℥i) and plugged for twenty-four hours with gauze. The bowels should be kept quiet for a week. In a large percentage of cases contraction takes place, necessitating the daily introduction of a bougie. In this operation the peritoneal cavity ought not to be opened; if it should be, a clean aseptic sponge should at once be introduced and the opening subsequently sutured.

In those cases where the cancer springs from one side of the rectum and does not involve the whole circumference of the gut, the operation may be modified by removing only that portion of the bowel from which the growth springs, taking care of course to cut widely of the disease. The prognosis in these cases is more favourable as regards recovery from the direct effects of the operation, and also after recovery there is less tendency to contraction and the formation of stricture.

As regards the question of recurrence, the prognosis is not good; in the majority of cases operated on, a recurrence has taken place and has proved fatal.

Kraske's operation.—Cancer of the rectum is frequently situated so high up that it cannot be reached by the proceeding above described. The operation which was introduced by Kraske and goes by his name is intended to deal with these cases, and in addition seems to offer much better chances of effecting a radical removal of the whole of the disease, and holds out much greater prospect of success. At the same time it is an operation of considerable severity, and must not be lightly undertaken. I am of opinion, however, that Kraske's operation should always be preceded by an inguinal colotomy. In the first place, because at the time of the colotomy an opportunity can be taken, by making the incision a little larger than usual, of introducing the hand into the pelvis, and thus accurately ascertaining the extent of the disease and how far it has implicated neighbouring parts, and thus definitely determining whether an operation is feasible or not. The condition of the lumbar glands can also be ascertained. Secondly, a preliminary inguinal colotomy materially improves the chances of a successful result after Kraske's operation by diverting the fæces from the wound during the process of healing. Should the case prove successful, the artificial anus in the inguinal region can be closed at a subsequent operation, as has been done in one if not more instances. Kraske's operation is performed as follows: The rectum is first thoroughly cleansed by swabs on long forceps, soaked in 1 in 500 corrosive sublimate solution, as high up as can be reached, or by irrigation with the same fluid. The patient is then turned over to the right almost on to his face, and an incision is made in the middle line of the body from the centre of the sacrum down to the anus. This incision is carried down to the bone, and all the structures separated from the posterior surface of the sacrum as far as its lateral border, with an elevator. The attachments of the greater and lesser sacro-sciatic ligaments to the sacrum are thus exposed and are to be divided. By introducing the elevator round the margin of the sacrum on to its anterior surface, the structures on this surface are raised from the bone, including the pyriformis, the coccygeus, the sphincter and the levator ani. The coccyx is now to be removed and a portion of the lateral border of the sacrum. With a chisel and mallet a cut is to be made commencing at the left border of the bone on a level with the third posterior sacral foramen, and carried down through the fourth foramen to the left cornu of the sacrum. This will remove sufficient bone to freely expose the rectum without injuring any of the sacral nerves or opening the sacral canal. The connections of the rectum are now to be torn through and the gut isolated by the fingers; this can easily be accomplished behind and at the sides, but in front care must be taken in separating it from the bladder and prostate in the male and the vagina in the female. After isolation the gut must be carefully palpated to ascertain the upper limit of the disease; if this extends to beyond the point to which it has been isolated, the recto-vesical or recto-vaginal pouch of peritoneum must be deliberately opened and the fold at the bottom of the pouch divided across, and the meso-rectum severed to a sufficient extent to reach well above the upper limit of the disease. So far the operation has been conducted without any fear of contamination, but now the greatest care will have to be exercised. A loop of elastic tubing fixed by a clamp should be made to encircle the bowel above the point where it is intended to divide it, and the parts packed round with sponges or plugs of gauze. The bowel is divided, and the cut ends at once wiped with gauze and dusted with iodoform. The lower part of the bowel has now to be dealt with. If the anal portion is free from disease it may be left, and the diseased portion cut away by dividing the bowel between the seat of the disease and the anus. If the disease extends too low for this, the anus must be cut away. The edges of the wound in the peritoneum after careful cleansing are now to be carefully sutured. If the anal portion has been left, the upper part of the gut may be drawn down and sutured to it. If the anal portion has been removed, an attempt should be made to bring the upper part down and suture it to the opening in the perineum; or if this is impossible or causes too much tension, it may be brought out at the upper part of the wound behind and fixed to the skin in this situation. The parts must now be thoroughly irrigated and the external wound closed, drainage tubes having been inserted, as union of the upper segment of the gut to the lower often fails in a part of its extent.

CHAPTER XV

INJURIES AND DISEASES OF THE URINARY ORGANS

Rupture of the kidney.—The kidney is not infrequently ruptured by direct violence, as blows or falls, buffer accidents, or from the patient being run over. The amount of laceration may vary, and the danger of the injury depends mainly upon whether the peritoneum has escaped injury or not, and whether one of the large branches of the renal artery or vein has been torn. If this is so, the injury will rapidly prove fatal. In less severe cases, a great deal depends upon whether the capsule has been torn. If it has not, hæmorrhage takes place into the substance of the kidney and its capsule, but is limited to the organ, and urinary extravasation is prevented. In some of these cases the pelvis and ureter may become plugged with extravasated blood, so as to obstruct the passage of urine down the ureter. When the capsule of the kidney has been torn, extravasation, not only of blood but also of urine, may take place into the perinephritic tissue and cause suppuration, which may terminate in death from pyæmia or exhaustion.

Symptoms.—The ordinary symptoms of rupture of the kidney are severe shock, accompanied by pain in the loin, shooting down to the thigh and testicle, and blood in the urine, following an injury to the abdomen. But it must be remembered that on the one hand there may be a severe laceration of the kidney and still no blood in the urine; and on the other hand there may be an injury to the abdomen, and blood in the urine, without any laceration of the kidney. When there is no hæmaturia the indications of the injury would be the presence of collapse and the signs of internal hæmorrhage; the presence of a swelling, which is dull on percussion in the loin, with perhaps some superficial bruising or indication of injury in this situation, combined with pain radiating from the loin to the testicle and thigh. When there is hæmaturia the amount of blood may vary considerably. Clots may form in the ureter, giving rise to colicky pains and suppression of urine on the affected side; or they may form in the bladder and may be passed per urethram. If the peritoneum has been injured, signs of traumatic peritonitis may set in; and in those cases where perinephritic abscess supervenes there is fever, rigors, and increased pain and swelling in the loin.

Treatment.—The patient must be kept strictly quiet in bed, and if there is reason to suppose that hæmorrhage in large quantities is going on, ergot of rye should be given. If pain is severe, a hypodermic injection of morphia should be administered. No food should be given by the mouth for the first twenty-four hours, and then only in small quantities. Bandaging the abdomen sometimes gives ease and comfort to the patient. If hæmorrhage is persistent and threatens life, the kidney must be cut down upon from the loin, and if necessary removed. In cases where clots form in and distend the bladder, the viscus must be washed out periodically with a large-eyed catheter. If symptoms of peri-nephritic abscess supervene, an incision must be made in the loin, and the kidney dealt with according to the condition found.

Wounds of the kidney are very rare in civil practice, and not common in warfare. When inflicted from behind they do not involve the peritoneum, unless perhaps in gunshot wounds, when the bullet passes completely through the kidney; but when the wound is in front, the peritoneum and very often some of the other viscera are injured.

The **symptoms** are those of collapse, with severe pain in the loin, often radiating to the testicle and thigh. There may be profuse bleeding from the external wound, or if it is of the nature of a punctured wound, blood may collect in the tissues around the kidney; or, if the peritoneum is wounded, in the peritoneal cavity. There is usually constant desire to pass water, and the urine may or may not contain blood. If the peritoneum is injured, symptoms of peritonitis speedily come on; if it is not injured, inflammation of the retro-peritoneal tissue, running on to suppuration, is likely to supervene.

Treatment.—If hæmorrhage is not excessive and the wound has been inflicted from behind, it should be thoroughly irrigated with solution of corrosive sublimate (1 in 1,000) or carbolic acid (1 in 20), and a large drainage tube inserted, the rest of the wound being closed; if the hæmorrhage is great and persistent, the wound in the loin should be enlarged, and the kidney exposed and dealt with as in the cases of rupture. If the injury is in front, the abdomen should be opened, not only in order to deal with the kidney, but also with any other viscus which may be injured. If the injury is extensive, and the bleeding profuse, the organ may have to be removed; if the injury is slighter in its nature, and the bleeding not profuse, the wound in the kidney must be sutured and the opening in the peritoneum closed over it. The peritoneal cavity must then be thoroughly cleansed of all blood clots and flushed, and the abdominal wound closed. The patient should be kept completely at rest; opium or morphia may be given to allay pain, and only small quantities of fluid food given by the mouth.

Rupture of the ureter.—Subcutaneous rupture of the ureter is not a common injury, and when it occurs is usually the result of direct violence, as a kick from a horse, or the passage of a wheel over the trunk. It may either be torn completely across or only partially divided, and the peritoneum usually escapes injury. If it is torn completely across, the urine collects in the retro-peritoneal tissues. If it is not torn completely across it may become obstructed, and hydro-nephrosis or pyo-nephrosis result. The symptoms in the early stage are obscure; pain and tenderness at the part injured, which may radiate to the loin, front of the abdomen, or groin, accompanied by transient collapse and vomiting, and with or without blood in the water. It is not until the appearance of a tumour and changes in the kidney take place that an accurate diagnosis can usually be made. The tumour is well defined, and can be felt both in front of the abdomen and in the loin, and fluctuation is often perceptible in it. The fluid, if withdrawn with an aspirator, is at first clear and presents the characters of urine; but after a time septic changes take place in it, and it contains pus. When inflammatory changes supervene there is fever, with increased pain, and the abdominal wall becomes red and eventually œdematous.

Treatment.—If a rupture of the ureter is diagnosed immediately after the injury, the treatment would be to cut down upon it and suture it; but usually the diagnosis is not made until too late for this. If a tumour has appeared, a free incision should be made in the lumbar region, the fluid evacuated and the cavity drained. An attempt should be made to find the injured ureter, and if it is completely torn across it should be sutured; if it cannot be found, a permanent fistula will be left. If it has not been completely torn across, the opening in it may eventually close. If disorganising changes have taken place in the kidney, it will necessitate nephrectomy.

The ureter may be accidentally wounded in some abdominal operations, such as ovariotomy, hysterectomy, and the removal of suppurating tubes and ovaries, or in operations for extra-uterine fœtation. If this should happen, and the surgeon detect the injury at the time, an attempt should be made to restore the continuity of the canal by inserting very fine silk sutures after Lembert's method, and then covering the injured part with peritoneum. If the ureter is completely divided, an end-to-end anastomosis, by invaginating the upper into the lower end; or a lateral anastomosis, by a lateral implantation of the upper end into an opening in the side of the lower end, must be attempted. Failing this, the upper end should be implanted into the bladder or the intestine.

Rupture of the bladder.—Rupture of the bladder is a formidable injury, which occurs in both sexes, but is more common in the male. It generally arises from a direct blow upon, or crushing force applied to, the lower part of the abdomen when the bladder is full, but has been known to be produced by violent blows on the back under similar circumstances. Subcutaneous laceration of the bladder may also be caused by fractures of the pelvis, either from a fragment perforating the bladder, or by a tearing of the bladder in cases of fracture without any perforation. Finally, the bladder may be ruptured, without injury, in cases of over-distension from retention of urine. This is a very rare effect of stricture, the urethra more commonly giving way; but undoubted cases have been recorded.

Rupture of the bladder has to be considered under two different aspects, as to whether the peritoneum is involved in the injury or not. This serous membrane only partially invests the bladder, covering the upper and back part from the urachus above to the lower part of the posterior surface, where it is reflected on to the anterior surface of the rectum in the male, and the uterus in the female. When a rupture implicating all the coats of the bladder takes place in this part, it is said to be *intra-peritoneal*. When the rupture takes place on the anterior surface, which is not invested by peritoneum, it is *extra-peritoneal*.

Intra-peritoneal rupture.—This is the more common lesion of the two, and in it the urine contained in the bladder finds its way into the peritoneal cavity and sets up peritonitis, which is almost always fatal unless operative measures are undertaken.

Symptoms.—There is the history of an injury to the lower part of the abdomen when the bladder was full. There is usually severe pain and collapse, but cases have been recorded where the pain was slight at first, and where there was no collapse. The patient is unable to pass water, and if a catheter is introduced into the bladder, no urine flows through it, or at most an ounce or two of bloody fluid. If, however, the catheter is moved about in the bladder, it may be insinuated through the rent in the viscus into the peritoneal cavity, when a considerable amount of fluid will flow through it, more than could be contained in a bladder which obviously was not distended before the catheter was passed. The manner in which the fluid flows from the catheter should be noted, as it is characteristic. It does not flow in a continuous steady stream, as when it is expelled from an intact bladder, but flows in leaps which correspond with the respiratory movements. In some cases when the catheter is in the peritoneal cavity, the point of it may be felt through the abdominal wall if the handle is depressed. If there is any doubt about the diagnosis, a useful test may be applied in the following way : a known quantity, say a pint, of hot boric acid solution is injected into the bladder and then allowed to return, and the amount which is returned is measured. If there is a rupture, a considerable quantity will find its way through the rent into the peritoneal cavity, and a less quantity will be returned than was injected. If no treatment is adopted, in a very short time symptoms of peritonitis will supervene, and the patient will probably die.

Treatment.—As soon as possible after the diagnosis has been made, the abdomen should be opened in the middle line, and the fluid in the peritoneal cavity thoroughly removed with sponges. The rent in the bladder should then be sought for and clearly demonstrated. It is to be sutured by a series of Lembert's sutures, which should extend a little beyond either extremity of the rent and be applied close enough to prevent any escape of urine. When the suturing is completed, the abdominal cavity should be flushed with hot normal saline or boric acid solution, and a Keith's glass drainage tube introduced into the recto-vesical pouch for a few hours, so as to remove any exudation. The rest of the wound is then sutured and dressed in the usual way. A red rubber catheter is introduced into the bladder, and to it is attached tubing which passes into a receptacle under the bed, and by its siphon action keeps the bladder empty.

Extra-peritoneal rupture is in most cases the result of fracture of the pelvis. The anterior surface or the base of the bladder is the part involved. The urine which escapes from the bladder infiltrates the cellular tissue of the pelvis and sets up a diffuse pelvic cellulitis, which often terminates fatally from pyæmia or toxæmia. Suppuration comes on, and abscesses point in the lower part of the abdomen and in the perineum.

The **symptoms** are to a certain extent the same as those of intra-peritoneal rupture. The patient is unable to pass water, and no water is drawn off when a catheter is passed, merely an ounce or two of bloody fluid ; but as the catheter cannot be made to leave the bladder, the urine is never drawn off. In a short time, symptoms of extravasation of urine, with inflammation, in the hypogastric region, supervene.

Treatment.—The treatment in these cases consists in at once performing a perineal cystotomy, so as to freely drain the bladder. Free incisions should then be made into all the parts into which urine has been extravasated, both above the brim of the pelvis and in the perineum, and drainage tubes inserted. As in these traumatic cases the urine is presumably healthy and free from bacteria, this treatment is followed by a large measure of success, especially in those cases, which however are rare, where the injury is not complicated with fracture of the pelvis.

Wounds of the bladder are generally the result of stabs or gunshot injuries when the bladder is full. They may, however, be caused by wounds through the rectum (see fig. 349). They may be intra-peritoneal or extra-peritoneal. The symptoms, in addition to the wound and shock, are that urine mixed with blood escapes from the wound; there is frequent desire to pass water, and little passes per urethram. During the efforts of micturition the urine may be forced through the wound. In some cases no urine escapes, but it collects in the peritoneal cavity or in the cellular tissue of the pelvis, producing the same symptoms as those mentioned above in cases of ruptured bladder.

The **treatment** consists in performing laparotomy and suturing the wound in the bladder.

Rupture of the urethra.—Rupture of the urethra may result either from traumatism or from over-distension of the bladder. Only the first class of cases will be considered here.

Traumatic rupture of the urethra is caused by violent blows on the perineum, crushing the urethra against the arch of the pubic bones. It may be produced therefore by a man walking across the floor of an unfinished house and falling astride one of the beams; or by falling from a height across a pole or gate; or by a rider striking violently on the pommel of his saddle; or by violent kicks in the perineum. The urethra may be completely or partially torn across. In other cases the urethra may be lacerated in fractures of the pelvis.

Symptoms.—The symptoms are sufficiently clear and definite. The patient is admitted with the history of a blow in the perineum, and more or less shock. There are swelling and bruising in the perineum and scrotum, and blood trickles from the urethra. If the patient attempts to pass water, the urine finds its way out of the lacerated urethra into the cellular tissue around, and then the swelling in the perineum is considerably increased.

Treatment.—The patient must be at once cautioned not to attempt to pass water. A catheter should, if possible, be introduced into the bladder; if the rupture is not a complete one, this can often be done by keeping the point of the instrument against the upper wall of the urethra. If the surgeon succeeds in passing an instrument, it should be tied in and allowed to remain there for four or five days, and afterwards a full-sized instrument should be passed daily for some time, as these injuries of the urethra are followed by a most intractable form of stricture. The patient will therefore require the occasional passage of a catheter for the rest of his life. If no instrument can be introduced, the patient must be placed in the lithotomy position, and an incision made in the median line of the perineum to expose the ruptured urethra. An attempt must then be made to find the proximal end of the torn tube; and if the surgeon keeps strictly in the middle line, it can usually be discovered as it passes through the triangular ligament, about an inch below the symphysis pubis. When found, a broad director must be passed along it into the bladder. An ordinary full-sized catheter is introduced through the penile portion of the urethra, and, guided by the director, is carried onwards into the bladder and tied in. An effort should now be made to suture the two ends of the ruptured urethra together. If this can be done it is a great gain to the patient, for not only is the danger of urinary infiltration lessened, but the probabilities of the formation of an intractable stricture are also materially reduced; but in the greater number of cases it is impracticable, and to clearly expose to view the ends of the urethra at a great depth, among a mass of lacerated tissues infiltrated with blood, so as to insert the sutures, is impossible. In those cases where the proximal end of the urethra cannot be found, so that a catheter cannot be passed, the surgeon must be content with his free incision into the perineum, through which the urine will escape. The patient must be kept in bed until the extravasated blood has been absorbed, and then another attempt must be made to pass an instrument. When once a catheter is passed it must be tied in and kept there for several days, until the continuity of the canal is re-established. In all cases the after treatment by frequent catheterism must be rigidly persevered with.

Foreign bodies in the urethra.—Foreign bodies may be introduced into the male or female urethra. They may either remain in the urethra, or may travel backwards into the bladder, which is particularly liable to occur in the female, or in rare instances they may be expelled. If they remain in the urethra, they must be of such a nature as not to completely occlude the canal, and they may be retained either in the penile or deeper portion of the canal. They become coated with the salts of the urine, cause ulceration of the mucous membrane and dilatation of the urethra behind. When they pass backwards into the bladder, they become coated with phosphates and form the nucleus of a calculus. In the treatment of these cases, a good deal will depend upon the situation of the foreign body; if it is near the meatus, it can often be extracted by fine urethral forceps or a bent probe. If situated farther back, the best plan is to push it backwards into the bladder, and then crush it and remove the fragments, as in cases of calculus in the bladder (see Litholapaxy). If this is impossible, the foreign body must be cut down upon as it lies in the urethra, and extracted; but this is very likely to be followed by a fistula, which is very difficult to heal. If the foreign body has passed back into the bladder, it must be crushed; or if it has become incrusted with the salts of the urine, so as to render it too hard or large to crush, it must be extracted by lithotomy. One of the most troublesome foreign bodies to deal with is a hair-pin in the female bladder. It is occasionally introduced down the urethra by neurotic women, and slipping into the bladder, the points become entangled in the mucous membrane and render it very difficult to extract. The best plan is to dilate the urethra so that the finger can be introduced, and then the pin can be seized and withdrawn by means of a blunt hook which is passed over the bend in the pin.

SURGICAL DISEASES OF THE KIDNEY

Malformations of the kidney are of little clinical importance. Among the most common is the so-called *horseshoe kidney*, which consists of a fusion of the two kidneys at one end by renal or merely fibrous tissue; in other cases the two kidneys may be fused along the whole length of their internal borders, forming a disc-shaped mass in the middle line. Another malformation is where there is congenital atrophy of one kidney, the other being proportionally enlarged. This is a matter of serious import when the working kidney becomes disabled from any cause, as in a case which occurred under my care, where the ureter became blocked by a calculus. Occasionally a third kidney may be present, as in a case under the care of Mr. Watson Cheyne, where a well-developed third kidney was found on the right side of the lower part of the spinal column, just at the brim of the pelvis. Other malformations are the persistence of the fœtal lobulation; the presence of two pelves or two ureters to the one kidney.

Displacement of the kidney.—Abnormalities in the position of the kidney may be (*a*) simple congenital displacement; (*b*) movable kidney; (*c*) floating kidney.

a. **Simple congenital displacement** usually affects the left kidney, and it is generally displaced downwards on to the left sacro-iliac joint, or on to the promontory of the sacrum. In these cases the descending colon is also displaced to the right, so that the rectum begins on the right side of the body; and the renal artery, or, if there are two, one of them comes off from the aorta close to the bifurcation of this vessel. This displacement may give rise to difficulty in child-bearing, or it may be mistaken for an abdominal tumour. In the majority of cases the condition is not suspected during life, and is only discovered post mortem, or it may be detected accidentally on vaginal or rectal examination.

b. **Movable kidney** is where the kidney is mobile in the tissues by which it is surrounded, either moving in its capsule, or else moving with the capsule in the peri-nephritic tissue. It is an acquired condition, and is more common in the female than in the male.

c. **Floating kidney** is supposed to be a congenital condition, arising from the peritoneum almost completely enveloping the kidney, and then passing backwards to the spine as a double layer, forming a mesonephron. Some doubts have, however, been expressed as to the real existence of this condition.

The **symptoms** of these two latter conditions may be considered together. They consist of a painful dragging sensation in the loin which is increased by exertion and relieved by rest. Occasionally there may be severe paroxysmal pain, resembling renal colic. Accompanying this there is vomiting, flatulence, and general gastric disturbance. Upon examination a movable tumour can be felt, which has the outline and size of the kidney. This is best perceived with the patient in the erect position.

The **treatment** consists in adapting a specially shaped pad and abdominal belt, which will retain the kidney in its normal position and support it. This is generally all that is necessary; but where it does not prove sufficient to relieve the pain and other symptoms, the operation of nephrorrhaphy must be resorted to.

There are several ways of performing this operation. Perhaps the simplest, and at the same time as efficacious as any, is the plan advocated by Mr. Morris. The kidney is exposed in the loin by the usual incision, and is attached to the cut edges of the transversalis fascia and the aponeurosis of the transversalis muscle by three sutures dipped deeply into the posterior surface of the organ, and running for from three-quarters of an inch to an inch in its substance. Mr. Morris employs fine silk for his suture. Tuffier and others recommend that the proper capsule of the kidney should be stripped off the posterior surface, and the portion, thus rawed, united to the abdominal parietes; and Vulliet suggests taking a long slender slip of the tendon of the erector spinæ. This is isolated, passed through the muscular tissue of the abdominal wall, and then beneath the capsule of the kidney, and finally back again through the muscular mass, to be attached to the erector spinæ; it thus forms a sling for the kidney.

Diseases of the kidney secondary to diseases of the other urinary organs.—Diseases of the lower urinary organs, such as long-standing stricture, enlargement of the prostate, or disease of the bladder, may cause serious organic changes in the kidney, viz. (*a*) acute or sub-acute interstitial nephritis; (*b*) suppurative pyelo-nephritis; (*c*) hydro-nephrosis; (*d*) pyo-nephrosis; (*e*) peri-nephritis. These secondary changes are set up in the kidney as the result of three conditions: (1) increased pressure in the tubules, from obstruction to the escape of urine; (2) reflex irritation of the kidney; and (3) septic matter in the pelvis of the kidney, and the invasion of the kidney by septic organisms.

a. **Acute or sub-acute interstitial nephritis.**—This condition, though primarily owing its origin to some disease in the lower urinary organs which has caused obstruction to the flow of urine, and therefore undue pressure on the tubes of the kidney, is liable to be excited by some reflex irritation, such as the passing of a catheter in a case of old-standing stricture. It affects both kidneys, though frequently one is much more implicated than the other. They become soft and swollen; their capsules opaque and adherent, and their surfaces coarse and granular, presenting a mottled appearance, the stellate plexuses being particularly marked. On section of the kidney, the pyramids are found to be intensely injected and the structure soft and tumid.

Symptoms.—In the *acute form* the disease usually begins after some surgical procedure, and is generally ushered in with a severe rigor, the temperature mounting to 104° F. or 105° F. This is followed by profuse sweating, and the temperature falls, but does not regain the normal, remaining one or two degrees above it. The patient lies in a semi-drowsy condition; there is nausea and vomiting, and generally diarrhœa; the skin is hot and pungent; the tongue dry, red, and fissured; the pulse quick, small, and weak. There is great distaste for food, and rapid emaciation. Frequently a crop of herpes appears about the lips. The urine is usually scanty, blood-stained, and contains a trace of albumen, but in some cases a considerable quantity is passed; in the later stages there may be suppression. Upon making deep-seated pressure over the kidney, pain is elicited, and the patient frequently complains of aching in his loins.

In the *sub-acute form* the symptoms come on much more insidiously. The patient is weak and languid, loses his appetite, and complains of nausea. There is a nightly rise in the temperature of one or two degrees. The patient gradually loses flesh. A fair amount of urine is passed, but as there is usually some antecedent bladder trouble which alters the character of the urine, no information can as a rule be obtained from its examination. The sub-acute form may after a time become acute, and these cases are generally fatal. Drowsiness sets in, with low muttering delirium, and this is followed by coma and death. In those cases which terminate favourably, the symptoms gradually disappear.

Treatment.—The cause of the obstruction which has set up the disease must, if possible, be removed, or at all events the free exit of the urine from the bladder must be provided for. The skin should be kept acting by the administration of diaphoretics, hot-air baths, &c. The patient must be confined strictly to bed, in an equable temperature. Fluid diet, principally milk, should be given. Dry cupping to the loins is said to be beneficial.

b. **Suppurative pyelo-nephritis.**—This condition is inaptly termed *surgical kidney*, probably because it occurs in the course of many surgical conditions of the lower urinary organs, sometimes from the want of proper surgical aid, and in others from causes beyond the control of the surgeon and in spite of efficient catheterism and irrigation of the bladder. It is usually due partly to backward pressure and partly to the extension of septic inflammation, and there is dilatation plus inflammation; the former preceding the latter, which goes on to suppuration.

The pelvis and calyces of the kidney are dilated; the lining membrane is injected and swollen, and secretes a muco-purulent or purulent fluid; to this succeed ulceration, and the formation of scattered abscesses in the renal tissue. The inflammation may extend through the kidney to the peri-nephritic tissue, and a urinary abscess in the loin may be the result.

Symptoms.—When a patient, the subject of stricture, enlarged prostate, stone in the bladder, or any other disease which causes cystitis and a fœtid condition of the urine, develops symptoms of fever, with possibly rigors; a hot, burning, pungent skin; a dry, furred, fissured tongue; headache, nausea, and vomiting, followed by drowsiness and rapid emaciation, there is very little room to doubt that he is the subject of this condition. There is usually pain and tenderness over the affected kidney. The urine varies. It is usually more or less bloody, and is in a state of decomposition, and contains pus; but whether the pus comes from the kidney or bladder cannot in general be ascertained, for the acid urine secreted by the kidney is neutralised by changes which take place in the bladder.

These cases usually prove fatal; but if the cause which gave rise to the condition can be speedily removed, recovery may take place.

The **treatment** is much the same as for interstitial nephritis, but is, as a rule, of little avail.

Cicatricial kidney is a form of granular kidney, which occurs in cases of recovery from either of the preceding conditions, either simple interstitial nephritis or suppurative pyelo-nephritis. It is produced by the cicatrisation of the inflammatory infiltration, and causes the kidney to become small and granular on the surface.

c. **Hydro-nephrosis** is a term applied to cases of dilatation of the kidney from over-distension with urine, the result of some mechanical obstruction. It would seem probable that in a large number of these cases the primary cause in the production of the dilatation is hypertrophy of the muscular coat of the bladder, no matter what may be the cause of this hypertrophy. When the muscular coat is thickened, there is obstruction at the orifice of the ureter, from its oblique direction through this coat, and hence there is distension of the ureters and pelves of the kidneys which causes their dilatation (fig. 357). Hydro-nephrosis may, however, occur as a congenital condition. In a large number of these cases it is due to an imperforate urethra, and the child is either born dead or dies shortly after birth. It may also be due to twistings or abnormalities of the ureter, and then may only affect one kidney.

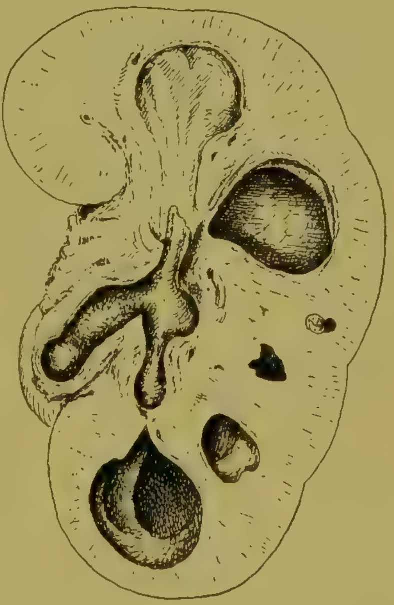

FIG. 357.—Dilatation of the ureter and pelvis of the kidney, from blocking of the ureter by a calculus. (From the Museum of St. George's Hospital.)

In hydro-nephrosis, the pelvis and calyces are dilated at the expense of the kidney structure. Upon laying the kidney open, the pyramids are found to be absent, and the cortex is thinner than natural, and of a somewhat opaque whitish tint and tough consistence. This surrounds a bag of cysts, freely communicating with each other, and lined with a smooth membrane continuous with that lining the ureter. The size of a hydro-nephrotic kidney varies considerably; it may be no larger than a normal kidney, or, on the other hand, it may attain enormous dimensions, so as to occupy a considerable portion of the abdominal cavity.

Symptoms.—The symptoms are few, unless the dilatation is so great as to produce a tumour. The most characteristic sign if both kidneys are affected is, in the early stage, an increase in the amount of the urinary secretion, with a low specific gravity. Later on there is a diminution in the secretion, with thirst, pain in the back, and intermittent anuria, followed at last by complete anuria and uræmia. If only one kidney is affected these symptoms are absent, as the increased growth of the sound kidney compensates for the diminished secretion of the diseased one. The tumour when present is lobulated, elastic, and sometimes fluctuating, and is dull on percussion. It is best felt by a bimanual examination, when it can be detected both in the flank and from the front. A characteristic symptom is that it varies in size, being much larger sometimes than at others. It is usually painless.

Treatment.—The first essential point in the treatment is to ascertain and if possible remove the obstruction which is the cause of the distension. If this can be done, and the tumour has attained no great size, no further treatment is necessary. But if the cause of the obstruction cannot be removed, very little can be done if the hydro-nephrosis is bilateral; no medical treatment is of any avail. If the disease is unilateral two courses are open to the surgeon: either repeated aspirations may be performed, but the result is rarely satisfactory; or the diseased kidney may be exposed by an incision in the loin. In some cases, as for instance where the ureter is blocked by a calculus, the stone may be removed, and a cure effected; but if not, and the kidney structure is almost entirely destroyed, nephrectomy should be performed.

d. **Pyo-nephrosis,** or dilatation of the pelvis and calyces of the kidney with pus, is often an advanced condition of hydro-nephrosis, suppuration extending from the bladder to the previously dilated pelvis and calyces of the kidney. It may also be the result of pyelitis, the formation of pus preceding the dilatation. In these latter cases the inflammatory condition causes a blocking of the ureter, either from swelling of the mucous membrane, or a clot of blood, or a little inspissated pus, and this leads to the retention and subsequent dilatation.

In pyo-nephrosis the same destruction of the pyramids and secreting structure of the kidney takes place, and the same formation of dilated pouches opening into the pelvis, as in hydro-nephrosis; but the lining membrane of the cavity is thickened, injected, and often ulcerated, and the dilated pouches are full of decomposed urine mixed with pus. What kidney structure remains is also inflamed and very often studded with foci of suppuration, and the tissues around the kidney are often involved in the general inflammation.

Symptoms.—The symptoms are those of enlargement of the kidney, with pain and tenderness. If the obstruction is not complete there will be pus in the urine, which will probably be acid, unless there is also a condition of cystitis present. If the obstruction is complete there will be no pus, but in many cases an intermittent discharge of pus will be noticed, according as to whether the obstruction is complete or not. The constitutional symptoms consist in an elevation of the temperature, especially at night, possibly a rigor, nausea and sickness, diarrhœa, with loss of appetite and gradual deterioration of strength. If the disease is chronic, symptoms of hectic supervene. If both kidneys are involved, the case generally terminates fatally, either from toxæmia, pyæmia, or uræmic poisoning.

Treatment consists in the early stages of removal, if possible, of the cause of the obstruction and distension. If both kidneys are affected, no operative interference is permissible, and palliative treatment is only possible; but if one kidney only is affected, it should be exposed by an incision in the loin, and if any cause of obstruction can be found, it should be removed. If not, the abscess cavity should be opened and drained. Nephrectomy may subsequently be required, but it is better to defer this operation until the parts have been efficiently drained and got into as healthy a condition as possible.

e. **Peri-nephritis,** or inflammation of the cellular tissue and fat around the kidney, is usually the result of the extension of inflammation from a suppurating pyelo-nephritis, but may occur as a primary condition, without any disease of the kidney, from a wound, or consecutive to disease of some other organ than the kidney. It also occurs occasionally as a sequel to one of the exanthemata.

The disease may be acute or chronic, and the symptoms will vary accordingly. They are those which attend the formation of deep-seated pus in other parts of the body. In the acute form there is fever, with probably rigors, deep-seated throbbing pain, with the formation of an indurated swelling, which after a time becomes soft and fluctuating, and tends to point in the loin. The skin in this situation becomes dusky red and œdematous.

In the chronic form the symptoms are obscure, until a swelling forms in the neighbourhood of the kidney. There is, however, prior to this a sensation of uneasiness and weight in the lumbar region, and the patient walks lame because he is unable to completely extend the thigh on the pelvis. There is also in these cases obstinate constipation. The chronic condition is very liable to be mistaken for lumbar abscess from Pott's disease, but can be diagnosed by the absence of any signs of disease of the vertebræ.

Treatment.—The treatment consists in both class of cases in making an incision along the outer border of the erector spinæ and evacuating the pus. The finger should then be introduced, and an endeavour made to find out the cause of the condition, and, if possible, remove it. If this cannot be done, renal fistula is very likely to follow.

Uræmia is a constitutional condition which may be set up by any of the above forms of disease of the kidney, and is caused by retention in the blood of matters usually eliminated by the kidneys. In consequence of this, decomposition products, as kreatin, leucin, and extractives are present in the tissues, and give rise to a certain train of symptoms. In addition the quantity of acid excreted is lessened, and the alkalinity of the blood is diminished.

Symptoms.—In the early stage the patient complains of general malaise, headache, and nausea, and sometimes vomits, especially in the morning, the vomited matter smelling of ammonia. Dimness of vision and shortness of breath are also complained of. The pulse is slow, there is considerable mental inactivity, and often hiccough, indigestion, and diarrhœa, with loss of appetite. These symptoms are followed by epileptic convulsions and complete insensibility.

The **diagnosis** of this condition in its later stages is sometimes difficult; it may be mistaken for epilepsy, apoplexy, or opium poisoning. From epilepsy it is to be distinguished by the history, the state of the urine, and the turgidity of the face, and by asphyxial symptoms not being so marked; from apoplexy, by the absence of paralysis; from opium poisoning, by the state of the pupils, which are dilated in uræmia, and by the coma, which is continuous in opium poisoning, often interrupted in uræmia. There is also no stertor, and the face is pale.

Stone in the kidney.—A concretion of the crystalline particles, which are usually held in solution in normal urine, may take place, and thus a stone may be formed in the kidney. In the great majority of cases, this stone, before it has acquired any large size, is carried by the stream of water down the ureter into the bladder, and may be voided during the act of micturition, or may remain in the bladder and being added to by fresh depositions from the urine may increase in size. In its passage down the ureter, a certain train of symptoms is set up, which are known under the name of *renal colic.* But this does not always occur; the stone may be retained in the kidney, and then several different conditions may result.

(1) The stone may become encysted, and causing no pain or inconvenience may remain undetected and unsuspected during the rest of the patient's life. It occasionally happens that upon making a post-mortem examination of a patient who has died of some other disease, an encysted stone is found in one or other kidney, the presence of which was entirely unsuspected by the patient during life. Indeed, in some cases the whole of the kidney may be found packed with large calculi, which have produced no symptoms (fig. 358). (2) In other cases the stone may be retained in the kidney and give rise to irritation and a very definite train of symptoms, which may necessitate operative interference for their removal. (3) In other cases, especially if the stone is lodged in the pelvis of the kidney, a pyelitis may be set up, and this may lead to pyo-nephrosis, when the pus secreted cannot find an exit down the ureter. This may be further complicated by a peri-nephritis, and an abscess may form in the loin, through which the stone has in some rare instances been known to be discharged.

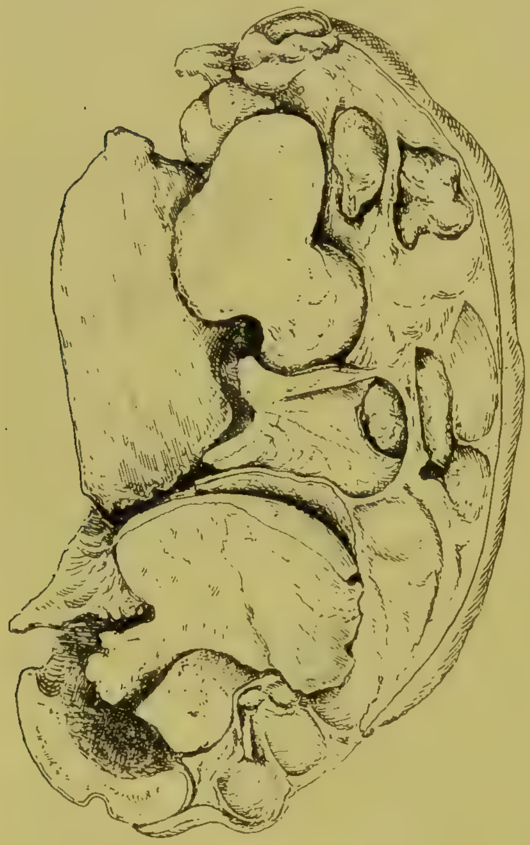

FIG. 358.—Kidney full of calculi, which produced no symptoms during life, and were discovered at post-mortem examination. (From a preparation in the Museum of St. George's Hospital.)

The most common form of calculus which is found in the kidney is the lithic acid, or in quite young children the lithate of ammonia; but not unfrequently, especially in individuals over the age of forty, oxalate of lime may be the chemical composition of the stone. Under rare circumstances the stone may consist of cystic oxide, xanthine, &c. They vary much in size, and are sometimes round and smooth, sometimes rough and branched, and when situated in the pelvis of the kidney take the form of that cavity. When many stones are contained in the kidney they may be variously facetted.

Renal colic.—A very small stone may form in the kidney and pass down the ureter without giving rise to any symptoms, but if it is of any size it irritates the mucous membrane, and gives rise to reflex spasm of the muscular coat, which produces a very severe train of symptoms. The patient is seized with intense and agonising pain in one loin, radiating down to the groin and into the testicle. The pain comes on quite suddenly and is paroxysmal in character. It is accompanied with shock, a sub-normal temperature, and a quick and weak pulse. The patient will often be found lying in bed, writhing in pain, faint, and his face bedewed with a cold and clammy sweat. There is always nausea, and very often actual vomiting. He is constantly making efforts to pass water, but as a rule passes only a few drops, and this is usually blood-stained. The symptoms suddenly cease when the stone enters the bladder, or when, as sometimes happens, it slips back into the pelvis of the kidney.

The **treatment** consists in these cases in administering a full hypodermic injection of morphia, and putting the patient into a hot bath (105° F.) to produce faintness and relaxation of the muscular coat of the ureter. Bland diluent drinks should at the same time be given. If this fails to relieve the pain, chloroform should be administered, and while the patient is under its influence massage in the course of the ureter may be employed, in order to assist the descent of the stone.

Stone in the kidney.—**Symptoms.**—The patient complains of pain which is usually referred to one loin, and radiates from this point in the course of the genito-crural nerve down to the groin, the testicle, and the inner side of the front of the thigh. The pain is more or less persistent, often paroxysmal in its nature; it is described as being 'sickening' in its character, and is aggravated by movement. There is usually tenderness, often acute pain, on deep palpation over the kidney, but no enlargement can, as a rule, be felt unless there is pyo-nephrosis as well. If the stone is of considerable size, it may be felt, and in one case under my care where there were two stones, I was able to move them on each other and produce grating. Frequency of micturition may or may not be present. The presence of blood in the urine is an important sign. In nearly every case of stone in the kidney there will be the history of the passage of blood at some time, and in most cases a few blood corpuscles will be found upon microscopic examination. In some the hæmorrhage is at times very considerable, coming on for a period and then subsiding. It is often increased by violent exertion, riding on horseback or in a carriage over a rough road. It may also be increased by the manipulations attending an examination of the case. Later on pus may be found in the urine, when pyelitis has been set up. Under these circumstances the pain becomes more acute and persistent, and there is greater frequency in micturition. There is also a rise in the temperature, especially at night. The amount of pus varies, sometimes it is very considerable, but the urine in which it is contained is acid. This is an important feature, as showing that the pus in all probability comes from the kidney and not from the bladder. The pus which is formed in the pelvis of the kidney may collect there, being prevented to some extent at all events from passing down the ureter, by the mouth of this tube becoming blocked, it may be by the stone or by the thickened lining of the cavity. The pelvis then becomes dilated, and a condition of pyo-nephrosis is set up. Upon examination of the urine crystals of lithic acid or oxalate of lime may be found in it, which will give a clue to the chemical composition of the stone.

These are the symptoms which are produced in a case of stone in the kidney under ordinary circumstances; but it must be borne in mind, as stated above, that a stone or several stones may exist for years in a kidney without giving rise to any of the symptoms enumerated above.

Diagnosis.—The diagnosis of stone in the kidney is often a matter of great difficulty, especially in those cases where there is no history of renal colic; and even where there is a history of symptoms which may be believed to be those of renal colic, these may be due to some other condition, such as spinal caries, impacted gall stones, typhlitis, and other abdominal affections. In a certain proportion of cases where a kidney has been cut down upon under the supposition that it contained a stone, but in which no stone was discovered, it will be found that the symptoms are entirely relieved by the operation, and the operator will probably notice in these cases that the kidney is small, dense in structure, with a thickened capsule, and that it is retracted under the ribs. These are cases in which there has been interstitial inflammation, and when any sudden afflux of blood takes place pain is experienced because the tense resistant capsule will not yield. The condition is relieved by the division of the capsule made in the exploration for the stone. Among other conditions which may simulate stone are: (1) excess of lithic acid or oxalate of lime in the urine; (2) tuberculous disease of the kidney; (3) a movable kidney, causing kinking of the ureter; (4) a dilated and inflamed pelvis.

In doubtful cases it is always desirable to employ radiography before proceeding to operate; but so far the results have not always been as good as could be desired. In thin people and children it has been found in some cases that undoubted evidence of the presence of a stone has been furnished by a skiagraph; but in the strongly built, muscular adult, or in the obese, the investigation has often given negative results. It has been proposed to throw the Röntgen rays upon the kidney after it has been exposed at the operation, and examine the viscus with a fluoroscope screen in order to obviate the necessity of opening the kidney.

Treatment.—In the early stages, when after an attack of renal colic the stone has not descended into the bladder, or when the symptoms indicating stone in the kidney are present, a certain amount of time should be allowed to elapse, in the hope that the stone may succeed in passing down the ureter, and during this time certain dietetic and medicinal remedies should be resorted to. Nitrogenous food in excess should be avoided, and the diet should be plain and unstimulating. The urine should be kept alkaline by Vichy or lithia water, and alkaline purgatives administered, and the patient should drink largely of distilled water to wash out the kidneys.

If after the lapse of a certain short period of time the stone does not pass down the ureter into the bladder, and the symptoms of irritation still persist, the operation of nephro-lithotomy for the removal of the stone should be undertaken. It must be borne in mind that calculous pyonephrosis is the result of long-standing irritation of the kidney from a stone, and that this can only be prevented by the removal of the offending foreign body. Even in those cases where the calculus is quiescent and gives rise to no renal or transferred pain, it is almost as dangerous to the individual as when it gives rise to severe symptoms, and therefore its immediate removal should be recommended. Mr. Morris has laid down a very stringent rule in regard to these cases. 'When a renal calculus is suspected, it should be searched for; when known to exist, removed, without waiting in the hope that it may become encysted or spontaneously expelled.'

Nephro-lithotomy.—The patient having been placed on his sound side with the trunk well rolled over, and with a firm pillow under the flank, so as to render the loin on the affected side prominent, and the parts properly cleansed and prepared, an incision is made to expose the kidney, and this may be either oblique, vertical, or transverse. The one which I have always adopted, and which seems to answer all requirements, is in the first instance to make an incision from just below the free extremity of the last rib backwards to the outer border of the erector spinæ, almost horizontally, so that its posterior extremity is at least an inch below the level of the rib. This is necessary in order to avoid the chance of wounding the pleura, which sometimes extends below the level of the rib posteriorly. If at a later stage of the operation more room is required, this can easily be obtained by converting the cut into a T-shaped one, by carrying a vertical incision downwards from the middle of the first to the crest of the ilium, or by continuing the horizontal cut forwards in the same line, but care must be observed not to wound the peritoneum. The various muscular layers are then divided, and the transversalis fascia exposed and slit up on a director. The peri-renal fat is now visible, and the wound being well opened up by retractors, the fat is separated by the fingers until the kidney is exposed. An assistant makes firm pressure on the opposite side of the abdomen, so as to push the kidney up into the wound, and the organ is systematically explored by the finger of the operator. The finger is first passed down to the pelvis, and this part carefully examined; if a stone is present, it can generally be felt as a hard irregularity in this situation. If no stone is detected, the posterior and then the anterior surface is to be carefully palpated, and finally, a finger of one hand being introduced in front of the kidney, and a finger of the other hand behind, the kidney is carefully examined between the two. In this way a stone, if of any size, can generally be detected. If no stone is found, the kidney will have to be more freely exposed, and brought up to the surface of the wound. In order to do this, the extra incision mentioned above will have to be resorted to. This being done, and the kidney examined again between the finger and thumb without any definite result, it is to be punctured in various directions with a straight needle mounted on a handle. This is thrust into various parts of the organ, and may detect a stone by impinging against it. In my hands this method of exploration has never proved of any use, but it is right to try it before proceeding to the next means which we have for exploring the kidney. This consists in making a puncture with a tenotomy knife through the substance of the kidney into the pelvis. This puncture Mr. Lloyd recommends should be made at the lower end of the kidney in a direction upwards and inwards, so that the lowermost of the calyces is opened.

Through this puncture a small sound is introduced, and the pelvis and calyces of the kidney systematically explored. In this way a stone, if present, can usually be detected.

When the stone is found, a tenotomy knife is passed through the substance of the kidney down on to it, till the point of the instrument can be felt to grate against the stone; a director is then passed down by the tenotome, and along the director a pair of dressing forceps; by opening these the wound is dilated and the stone freely exposed. It can then most easily be removed by a scoop, which prises it out of its bed. In puncturing the kidney the hæmorrhage is usually very free for a few minutes, but it usually soon stops upon the application of a little pressure. If not, the wound in the kidney should be plugged with gauze, which may be removed at the end of twenty-four hours.

When the stone is situated in the pelvis of the kidney, this part must be incised and the stone removed; but under these circumstances urinary fistula is more likely to result, as wounds in this situation heal with much less readiness than wounds through the parenchyma. After the operation is completed a drainage tube should be inserted down to the opening in the kidney, the rest of the wound sutured and dressed with gauze and a thick layer of wood wool wadding impregnated with corrosive sublimate. This will require frequent changing, as it becomes soaked with urine, which will probably escape for three or four days.

When the stone in the kidney has set up a condition of pyo-nephrosis, and the organ has been converted into a bag of cysts, filled with pus, in which the stone or stones are lying, the operation of nephrotomy should first be performed.

Nephrotomy.—The kidney must be exposed by a similar incision to that for nephro-lithotomy. When the kidney is freely exposed and drawn up into the wound, it is to be punctured with a tenotome, and through the puncture a pair of dressing forceps inserted, by means of which the wound is dilated. When the pus has escaped, the finger is introduced into the abscess cavity, the stones felt for and removed with forceps, and the cavity well sluiced out with antiseptic solution and a large drainage tube inserted into the kidney. The rest of the wound is then sutured and dressed. In some cases, the source of irritation having been removed, the abscess cavity may fill up and the wound heal; but in many cases this is not so, a sinus persists and continues to discharge pus, and when it is known, from the exploration of the kidney which was made at the time of the nephrotomy, that the renal parenchyma was considerably destroyed, nephrectomy or removal of the kidney must be resorted to, provided there is reason to believe that the other kidney is in a sound working condition.

Nephrectomy.—This operation may usually be done by the lumbar incision which will be described in the sequel; but it must be borne in mind that the kidney must be removed from its capsule, and this latter structure left behind. There has in these cases been so much peri-nephritis that the structures around the kidney will be all firmly matted together and to the capsule, so that it will be found to be impossible to remove it.

Tuberculous kidney.—Tuberculous disease of the kidney may arise in two ways: It may commence as a primary deposit taking place in the kidney, or it may be the result of general tuberculous disease of the genito-urinary tract, and be due to an extension upwards from tuberculous disease of the bladder. Under these circumstances both kidneys are frequently affected, whereas in the primary condition one only may be involved. In addition to this tuberculous condition, the kidney may be the seat of disseminated tuberculosis as a part of a general tuberculous condition; but as this is rarely diagnosed during life, and is not in any way amenable to treatment, it need not be further alluded to. Primary tuberculous disease of the kidney begins as a deposit of grey granulations in the pelvis and calyces of the kidney. These caseate, extend, and invade the kidney substance, and set up a condition of pyo-nephrosis. The mucous and submucous lining of the pelvis of the kidney becomes thickened, and the disease often invades the ureter and extends downwards to the bladder. The tissues around the kidney may become involved, and a peri-nephritic abscess form, which may burst externally.

In the form of the disease which extends upwards from the bladder, the ureter is first involved; the mucous and submucous coats become the seat of tubercle and thickened by the formation of granulation tissue. The disease then invades the pelvis of the kidney, and its lining membrane undergoes the same changes; finally the disease spreads to the kidney substance, which becomes a mass of caseous material, breaking down into curdy pus (fig. 359). The kidney or kidneys become enlarged and lobulated, and can usually be detected by examination through the abdominal wall.

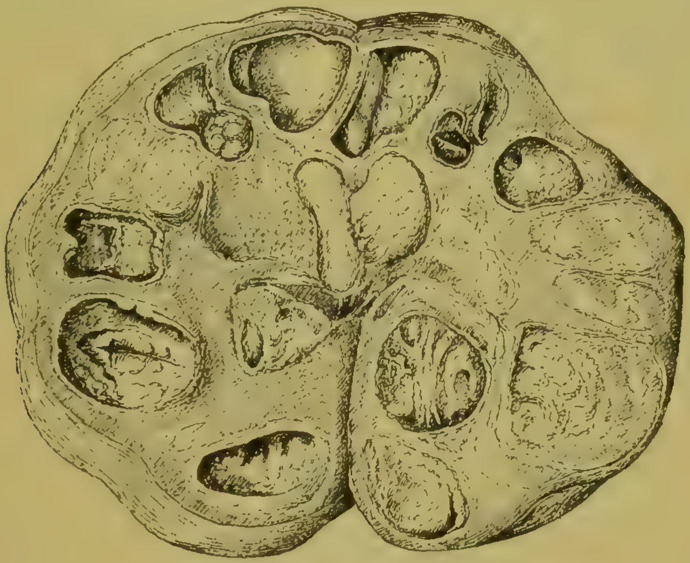

FIG. 359.—Tuberculous disease of the kidney. (From the Museum of St. George's Hospital.)

Symptoms.—The early symptoms of tuberculous kidney are often referred to the bladder, and the condition may be mistaken for cystitis. A patient applies complaining of great irritation of the bladder, and constant desire to pass water, with scalding during the act of micturition. The urine is examined and found to contain pus, and the case is at once put down as one of cystitis. The fact that the urine is *acid* and not alkaline, as it usually is in cystitis, should at once put the surgeon on his guard, and cause him to make a little more careful examination. He will then find probably that there is a dull aching pain in the loin, not as a rule, as in stone in the kidney, radiating to the groin or testicle, and upon examination of the abdomen some enlargement of one or both kidneys may be detected, and there will be no pain on pressure over the region of the bladder. The urine will be acid and contain a considerable amount of pus, but no crystals of uric acid or oxalate of lime will probably be found. By staining specimens of the urine, the bacillus tuberculosis may be discovered. Blood may be passed in the urine, but it is not common in tuberculous disease. If both kidneys are affected, the amount of the urinary secretion will gradually become diminished, and constant vomiting occur. Still later, when a condition of pyo-nephrosis is set up, the enlargement of the kidney becomes very perceptible, and this enlargement may be increased by the formation of a peri-nephritic abscess, which may burst externally, and the patient die of exhaustion. The diagnosis of tuberculous disease of the kidney from renal calculus is often a matter of extreme difficulty. The differential diagnosis between the two conditions is set forth in the following table :

Tuberculous disease.	Calculous disease.
Pus abundant.	Pus small in quantity.
Blood slight or none.	Blood often considerable at times.
Irritability of bladder common.	Irritability of bladder slight or absent.
Pain not radiating.	Pain radiating.
Bacilli to be found in urine.	Crystals to be found in urine.
Tuberculous diathesis and history.	No tuberculous history.
Enlarged kidney to be felt.	In many cases no enlargement of kidney to be felt.

Treatment.—The treatment of tuberculous disease of the kidney must depend very much upon whether the disease is primary or secondary to disease in other parts of the urinary tract. When it is secondary, it is probable that both kidneys are affected ; or if only one is diseased, there is a very strong probability that the other will become affected before long, and therefore any question of removal of the diseased organ is out of the question. But when the disease is primary, the age and strength of the patient are favourable, and there is no tuberculous disease elsewhere, removal of the kidney in whole or part seems to hold out a very fair prospect of success, provided the other kidney is in a healthy condition, and this must be ascertained at the time of the operation.

The **operation of nephrectomy** should in these cases always be done by the abdominal incision, so that the hand can be introduced into the peritoneal cavity, and the condition of the other kidney satisfactorily ascertained, before the removal is finally decided upon. The incision should be made in the semilunar line (Langenbuch's operation), so that the kidney may be approached from the outer side of the colon—ascending or descending, as the case may be ; the colic vessels are then not interfered with, as would be the case if the incision was made in the linea alba and the kidney reached from the inner side of the colon. When it has been definitely ascertained that the other kidney is in a sound working condition, the steps of the operation must depend upon how much disease is present in the affected organ. If the disease is strictly limited to one part, it may be sufficient to thoroughly scrape out the tuberculous cavity, purify it with a solution of chloride of zinc or pure carbolic acid, and plug the cavity with a strip of iodoform gauze, the end of which is brought out of the external wound. In other cases it may be possible to remove a wedge-shaped piece of the renal tissue and suture the cut surfaces. But as a rule it will be found that the whole of the kidney is practically destroyed, and that removal of the entire organ is indicated. The technique of the operation will be described later on.

Tumours of the kidney.—Tumours of the kidney may be classified into fluid and solid. Of the fluid tumours, hydro-nephrosis and pyo-nephrosis have already been alluded to, and these are the most common. More rarely we get cystic kidney; or cysts of two kinds—serous and hydatid—may be present in the organ.

Cystic kidney appears to be due to degenerative changes in the kidney. It may occur as a congenital condition, when it is believed to be due to degenerative changes in the embryonal structures, and both kidneys are usually affected; or it may occur in somewhat advanced life, when it is supposed to be due to degenerative changes in the interstitial connective tissue, which compresses the tubules and causes their dilatation. These cysts vary in size, and their contents may be clear and limpid; turbid and viscid; blood-stained or even purulent, but always contain urea. The walls of the cysts are lined with epithelium. In these cases the kidney may become converted into a mass of cysts, and attain an enormous size. The cysts do not communicate with each other, nor with the pelvis of the kidney. In the adult form of the disease one kidney only may be affected; or if both are involved, the disease is more extensive and further advanced in one than the other. In some instances, only a portion of one kidney is implicated. These tumours appear to cause little inconvenience in their early stage; later on they may cause pain and pressure symptoms from their size. They eventually cause the death of the patient from interference with the proper elimination from the blood of the materials excreted from the kidney.

Serous cysts are quite distinct from the small cysts often found on the surface of granular kidneys. They are cysts which originate in the cortical structure of the organ and grow out from the surface, probably being the result of the blocking of a tube. They are full of a thin fluid containing salts and albumen. They give rise to no symptoms, and, indeed, are rarely recognised until the post-mortem examination. If they attain a large size, they may form a discoverable tumour, which might require aspiration.

An **hydatid** tumour is rarely found in the kidney. If it attains a large size, it forms a rounded elastic tumour, which cannot be diagnosed as hydatid until its contents are examined, after aspiration. They may burst into the pelvis of the kidney, or, like hydatids elsewhere, they may suppurate.

Solid tumours of the kidney are most commonly sarcoma; but other forms of solid tumours are occasionally met with—of innocent tumours, papilloma, and rhabdo-myomata or myo-sarcoma; and of malignant tumours, carcinoma.

Sarcoma of the kidney may occur in early life, being either congenital or showing itself shortly after birth. It often affects both kidneys, is usually of rapid growth, and consists of a mixture of round and spindle cells.

The **symptoms** are those of a rapidly growing tumour, which may attain an enormous size, without pain or hæmaturia. They speedily kill the patient either from dissemination or pressure effects. Nothing can be done for them. They have been removed in many instances, but death has resulted either from the shock of the operation or from rapid recurrence.

Sarcoma in the adult is of the spindle-celled variety. It runs a less rapid course than the disease in infancy, is attended with hæmaturia, and usually proves fatal from secondary deposits taking place in other organs, or from exhaustion. The disease usually attacks only one kidney, but the results of the removal of the organ have proved most discouraging.

Papillomata are very occasionally found growing from the lining membrane of the pelvis of the kidney and forming a growth very similar to the villous tumour met with in the bladder. They give rise to profuse hæmaturia, with pain in the loin, and in some cases the growth may block the entrance into the ureter and set up a condition of hydro-nephrosis. The treatment consists in incising the kidney and scraping away the growth, if the condition can be diagnosed.

Rhabdo-myomata are tumours of interest only on account of the fact that they are growths which are supposed in part to consist of striped muscular fibre; but it is very doubtful whether the cells which present cross striation, and which are believed to be muscular tissue, are not really the fusiform cells of the sarcomatous element of the tumour. In other respects they possess the characters of sarcoma.

Carcinoma of the kidney as a primary growth is rare, but it occurs as secondary to carcinoma elsewhere. It presents the same clinical characters as the sarcoma—a rapidly growing tumour in the situation of the kidney, with often great irritability of the bladder. When the lymphatic glands become secondarily enlarged, those glands are affected which are in the immediate neighbourhood of the termination of the spermatic veins, and these vessels may be pressed upon and produce great turgescence of the veins of the cord in the scrotum.

The **diagnosis** of a renal tumour from other tumours, especially of the liver and spleen, is by no means always an easy matter. The tumour is best explored by a bimanual examination, when it will be felt to be more or less of the shape of the kidney, with a rounded outer surface, and perhaps a notch on its inner border. The greatest bulging in front will be on a level with or above the umbilicus, and as a rule it does not extend down into the pelvis. The colon is in front of the kidney, and unless displaced by the great size of the tumour, may give a more or less resonant note. Upon examination behind, there is dullness on percussion, which remains unaltered whatever the patient's position; and the dullness of the kidney is continuous with the dullness over the spine—that is to say, there is never any intermediate area of resonance between the two. The tumour moves very slightly with the movements of respiration, not nearly so much as do the liver and spleen. On the right side an area of resonance may frequently be detected between the dullness of the tumour and the dull note produced by percussing over the region of the liver.

Before leaving the subject of tumours of the kidney, it is necessary to mention that tumours are occasionally found growing apparently from the surface of the kidney, but which are not tumours of the kidney proper. They are really tumours, probably of an adenomatous nature, growing from accessory supra-renal capsules.

Nephrectomy.—The kidney may require removal in cases of tuberculous disease; in calculous pyo-nephritis; in hydro-nephrosis; after injury; in some cases of movable kidney where nephrorrhaphy has failed; and, it may be, in some cases of malignant growth in the kidney, where the disease is recognised quite early, though the results of operation up to the present time are far from promising.

Many different incisions and modes of proceeding have been adopted for removing the kidney. It may be removed from in front either by an incision in the linea alba or in the linea semilunaris: it may be removed from in front either with or without opening the peritoneal cavity; or it may be removed from behind through an incision in the lumbar region; or finally, it may be removed by a combination of the abdominal and lumbar incisions. It must be borne in mind that the essential point in connection with this operation is to ascertain as definitely as possible whether the other kidney is sound and in good working order or not. And though many different plans have been suggested for doing this, none of them are satisfactory except actual manipulation by the hand introduced into the abdomen. This is a strong argument in favour of abdominal over lumbar nephrectomy, or of adopting the plan advocated by Knowsley Thornton and others of making an abdominal incision first and ascertaining the condition of the other kidney, and then proceeding to remove the diseased one through a lumbar incision. In addition to this, the amount of room afforded for the operation by the lumbar route is not sufficient for the removal of a large kidney, and the pedicle is far more difficult to get at and manipulate.

It will be sufficient if we describe the abdominal operation by an incision in the semilunar line and the lumbar operation.

1. **Abdominal operation by Langenbuch's incision.**—This, as stated above, is the incision which should be made in cases of nephrectomy. The abdominal wall having been cleansed, an incision four inches in length is made in the semilunar line, commencing just below the costal arch, and the various layers cut through until the transversalis fascia is reached. This and the peritoneum are then opened together by a small nick with the scalpel, and divided to the full extent of the wound on a director. The hand is now introduced into the peritoneal cavity, and the opposite kidney carefully examined. If it is apparently healthy, the operation is proceeded with. The intestines are packed out of the way by a flat sponge, and the outer layer of the meso-colon divided and the capsule of the kidney exposed. The greatest care must be exercised not to injure the capsule in cases in which the kidney is being removed for a rapidly growing sarcoma, or if it is full of fluid. Where, however, the disease is calculous or tuberculous pyo-nephrosis, the capsule will have to be opened and the kidney enucleated from it. If the parts about the pedicle are free from adhesions, it is better now to expose the vessels, and, passing an aneurism needle under them, to tie them before enucleation of the kidney is commenced. If this is not possible, the organ is freed from surrounding tissues and gently lifted up from its bed. The ureter is first to be isolated from the vessels and tied in two places, and divided between the ligatures. In doing this, a sponge must be arranged so that if a drop of fluid escapes at the moment of section it may be received by the sponge. The cut ends are at once to be touched with pure carbolic acid, and may then be allowed for the present to drop back. The vessels are now to be ligatured with strong carbolised silk. It is better to tie the artery and vein separately, the vein being tied first; and in tying the ligatures they should be pushed well in towards the spine, so as to leave as much space between the ligature and the kidney as possible. If there is room, the pedicle should be clipped with a curved clamp or a pair of large Spencer Wells's clips close to the kidney, and the vessels divided with blunt-pointed scissors as near to the clamp as may be. The kidney can then be removed, and all bleeding vessels secured. If there is troublesome oozing, or the cavity has been fouled by the contents of the kidney, an opening should be made in the

loin and a drainage tube inserted through it. If the wound is dry and clean no drainage is required, but the wound in the abdominal wall may be at once sutured.

Recently Abbe and Mayo Robson have advocated a new incision for nephrectomy. The incision is made from a point one inch inside the anterior superior iliac spine, upwards and backwards, for four and a half inches in the direction of the fibres of the external oblique muscle. The fibres of this muscle and its aponeurosis are then split and retracted, exposing the internal oblique; the fibres of this muscle and the transversalis are split in a line between the ninth costal cartilage and the posterior superior iliac spine (fig. 360). A diamond-shaped space is thus formed, at the bottom of which is the transversalis fascia; this is incised, and the peritoneum freely exposed; it can be readily stripped from the front of the kidney. By retraction of the edges of the wound, the pedicle of the kidney can now be freely exposed, and the ureter can be separated and followed, if necessary, to the brim of the pelvis. The advantages claimed for this operation are that it gives free access to the kidney and ureter: that it can be done with the patient lying on his back, the most convenient position for the operator and his assistants, and the best for the anæsthetist: that no muscular fibres are divided, and therefore the edges of the wound fall readily together, and there is less tendency to the formation of a ventral hernia: that no vessels or nerves are divided, thus saving time and lessening shock.

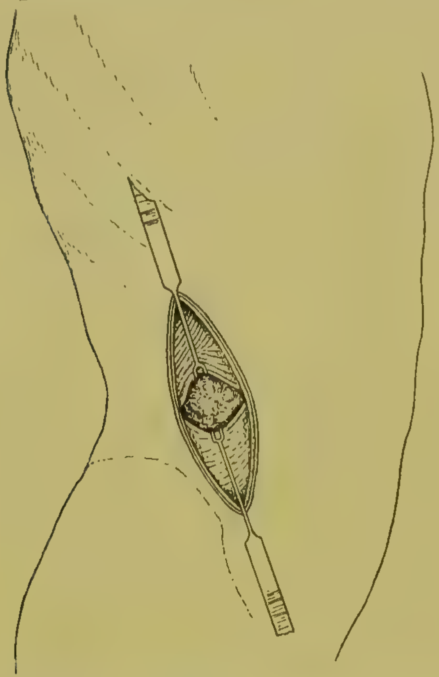

FIG. 360.—Diagram showing the mode of performing nephrectomy, as advocated by Abbe and Mayo Robson.

Lumbar nephrectomy.—The patient being turned well over to his sound side, the T-shaped incision described on page 941 is to be made and the kidney exposed. The capsule is then opened or not, according to circumstances (see pages 942 and 947), and the kidney carefully enucleated with the finger, care being taken to keep close to the organ, so as to avoid tearing the peritoneum. When the pedicle has been reached in front and behind, the kidney is to be lifted from its bed and drawn gently towards the wound, care being taken not to make too much traction on the vessels. If the ureter can be isolated, it is to be treated in the same way as in the abdominal operation. This is not, however, always possible in this operation, and all the structures at the root of the kidney will have to be ligatured *en masse*. An aneurism needle, armed with a double silk ligature, is passed through the centre of the pedicle, and it is tied in two parts. A clamp is then applied close to the kidney, and the pedicle divided between the clamp and the ligature, care being taken to leave sufficient pedicle to prevent the ligature slipping off. Occasionally the pedicle is too short to permit of this, and then the clamp will have to be dispensed with, and in some cases even a small amount of renal tissue will have to be left. In dividing the pedicle, sponges must be arranged so as to avoid fouling the parts. All bleeding having been arrested, a large drainage tube may be inserted if thought necessary, and the wound closed and dressed.

In the after treatment of nephrectomy, care must be taken to keep the patient warm and promote the action of the skin. There is often considerable shock, and this must, as far as possible, be guarded against (see page 41).

Hæmaturia.—The presence of blood in the urine may generally be recognised by the colour which it gives to the fluid. This will vary according to the amount of the blood. When this is considerable, the fluid has the appearance of coffee, and will stain red the bottom of the utensil in which it is contained. When the amount of blood is only small the urine has a smoky appearance, and a reddish-brown precipitate falls if it is allowed to stand. The more accurate way of ascertaining the presence of blood is by microscopic examination, when blood corpuscles will be readily detected.

The blood may come from any part of the urinary tract. When it comes from the kidney it is uniformly diffused throughout the whole volume of the urine, and upon microscopic examination blood-casts—i.e. clots of blood from the urinary tubules—may be detected. Occasionally larger casts may be seen, from clotting of the blood in the ureter. When it comes from the bladder, the urine first passed may be clear and normal, and become more and more tinged with blood, until, at the end of micturition, the fluid voided is almost pure blood. This, however, is not always the case; in some instances the blood is uniformly mixed with the urine. When the blood comes from the urethra it may be passed quite independently of the act of micturition, or in some cases a small quantity of nearly pure blood may be expelled at the commencement, and this is followed by urine which remains clear to the last drop. When the blood comes from the prostate or the prostatic portion of the urethra, it generally finds its way back into the bladder, and the signs are the same as those of bleeding from this organ: the blood appearing towards the end of the act of micturition, or else the blood being uniformly mixed with the urine.

When the blood comes from the kidney it may be due to many different causes: from injury, from inflammation, from malignant disease, from calculus, tuberculous disease, and from certain drugs, as cantharides. It may also occur in some general diseases, as hæmophilia, scurvy, and continued fevers, and may be due to the presence of minute worms (*Bilharzia hæmatobia*) in the kidney, or from the presence of the *Filaria sanguinis hominis* in the blood. When the blood comes from the bladder it may be due to injury of the bladder or prostate; to stone in the bladder; to growths, either villous or malignant; to acute cystitis or ulceration, tuberculous or otherwise; or to congestion of the prostate. When the blood comes from the urethra it may be due to laceration; to impaction of a calculus; to rupture of the corpus spongiosum; to tumours in the urethra; to ulceration, generally phagedænic; or to gonorrhœa.

Calculus in the ureter.—A stone in its passage from the kidney into the bladder may be arrested in the ureter, and it is probable in many cases in which a stone in the kidney has been diagnosed, an operation performed and no stone found, that the stone was lodged in some part of the ureter.

There are three situations in which it is most usually arrested.

1. About two inches from the kidney, and here it can be detected

at the time of the operation of nephro-lithotomy, and may be removed by an incision through the coats of the ureter, if it cannot be pushed backwards into the pelvis of the kidney.

2. At the brim of the pelvis, where the ureter presents a sharp bend. In this situation a stone was removed by Kirkham by an incision from the tip of the last rib to the anterior superior iliac spine. The ureter was opened, the stone extracted, and the patient recovered. No sutures were inserted in the ureter.

3. The stone may be lodged at the vesical orifice; it can then sometimes be detected by vaginal or rectal examination, and has been removed by incision through the vagina, and by dilatation of the urethra in the female, and by supra-pubic cystotomy in the male. Other calculi, low down in the ureter, have been removed by an incision similar to that for tying the common iliac artery, and the ureter has been reached without opening the peritoneal cavity. On referring to the literature on the subject, it is noticeable that in a large number of cases no sutures were employed to close the ureter, which appears to have healed without difficulty, and no fistula resulted.

DISEASES OF THE BLADDER

Extroversion of the bladder (*ectopia vesicæ*) is an arrest in development of the anterior wall of the bladder and the corresponding part of the abdominal parietes; in consequence of this, the posterior wall of the bladder presents at the lower part of the abdominal wall and is pushed forwards by the pressure of the viscera behind, and protrudes as a red velvety tumour (fig. 361). The exact etiology of the condition is not perfectly known, but it is believed to be due to a want of development of the anterior part of the allantois and the corresponding part of the ventral plates, which by their junction form the abdominal wall. There is in these cases no true umbilical cord, but the placenta and the tissues which ought to form the cord are spread out over the front of the abdomen, and constitute the anterior wall of the bladder during fœtal life. At birth, when these tissues separate, the posterior wall of the bladder is exposed. In after life the superficial structures around the extroversion present the appearance of cicatricial tissue where the placenta was adherent during fœtal life, and there is no umbilicus. The condition is usually associated with other abnormalities: there is epi-

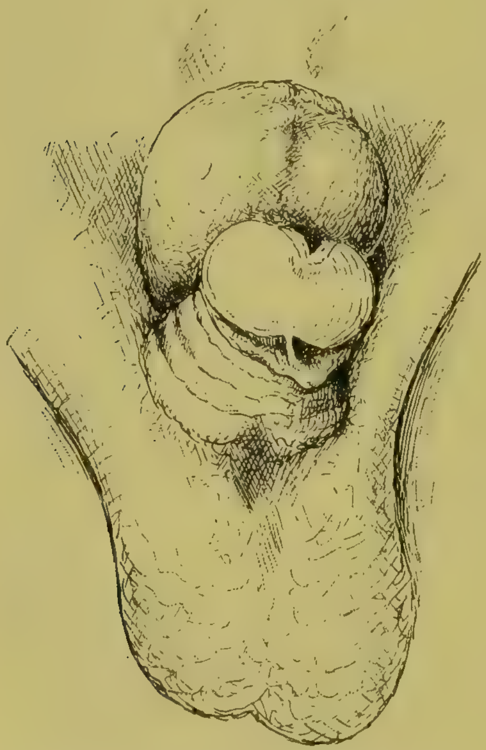

FIG. 361.—Ectopia vesicæ. (From a cast in the Museum of St. George's Hospital.)

spadias, or absence of the upper wall of the urethra; the penis, the body of which is rudimentary, but surmounted by a well-developed glans, is marked by a groove on its dorsal aspect, into the back of which the semen is discharged in adult life. The symphysis pubis is deficient, the bones of the two sides being merely connected by a fibrous band, which connects together the two superior rami of the pubic bones. The sacrum is somewhat convex from side to side, and this has a tendency to evert or throw outwards the innominate bones, and gives the child an unsteady and waddling gait. The testicles are often retained, and the scrotum undeveloped. If the testicles find their way into the inguinal canal, or even into the scrotum, the case is further complicated by the formation of a congenital hernia.

Symptoms.—Extroversion of the bladder shows itself as a florid, oval or circular swelling in the hypogastric region, which expands during coughing or straining. Its surface is very sensitive and bleeds readily, and on it may be seen two little projections, which are the orifices of the ureters, from which the urine can be seen exuding drop by drop. The results of this deformity are that the patient has no power of retaining the urine, which, constantly dribbling over the skin, is a potent source of irritation and annoyance. The mucous membrane of the posterior wall of the bladder is exposed to friction from the clothes &c., and being very sensitive is a constant source of pain, and, from its vascularity, frequently bleeds. The patient, if a male, is sterile. The disease may occur in either sex, but is much more common in the male than in the female; in the latter the disease does not render the patient sterile. The affection is not incompatible with long life, and some of the subjects of it are strong and otherwise healthy, but more frequently are weakly and stunted, and often succumb to a suppurative pyelo-nephritis, from septic inflammation spreading up the ureters.

Treatment.—Many ingenious operations have been suggested for the remedy of this distressing deformity, but up to the present time none of these have proved very satisfactory. Space cannot be afforded to do more than indicate some of the main features of these operations. The earliest attempts to effect a cure were by trying to divert the course of the urine into the rectum. This was first attempted by Sir John Simon, who endeavoured to establish a fistulous communication between the ureter and the rectum; and later on by Lloyd, who passed a skein of silk through the bladder into the rectum; and by other surgeons, who have made a puncture from the bladder and then introduced a soft metal or india-rubber tube. In some cases a fistulous opening may be established; but the operation is not devoid of danger, as the recto-vesical pouch of peritoneum in these cases often descends nearly to the anus, and is in great danger of being wounded. Subsequently, efforts were made by Wood, Holmes, and others by plastic operations, which consisted in transplanting flaps from neighbouring parts, to cover over the herniated mucous surface, and thus, at all events, save the patient from the constant friction from his clothes. It was hoped, moreover, that these transplanted flaps might be closed in at their margins, and that then, by establishing a fistulous communication between the bladder and rectum, the urine might find its way into the bowel and be passed per anum. One insuperable difficulty has always, however, attended these efforts, and that is, that the hairs which grow from the skin surface, which has been made to form the anterior wall of the new bladder, become incrusted with phosphates and form large calculous concretions, so that the united edges have to be broken down for their extraction. Anderson suggests making a new bladder by dissecting up the mucous membrane all round the margin of the extroversion for about half an inch, and then bringing the flaps over and uniting them together in the middle line. The skin around the margin of the extroversion is then dissected up from within outwards, and the two flaps brought together in the middle line over the reflected mucous surfaces, tension being relieved by lateral incisions. The operation is ingenious, but failed in the case in which Anderson tried it, as it did also in a case under my own care. Trendelenburg divides the posterior ligaments of the sacro-iliac joints, and by compression approximates the two pubic bones; in consequence of this, the protruding vesical wall recedes and forms a sort of hollow, which he subsequently closes by a plastic operation. The operation must be done before the child is five, and is a very severe one at so young an age; and in addition to this, it further weakens the already weak pelvic arch. Reginald Harrison proposes to remove one kidney, and, after the other has undergone compensatory hypertrophy, to transplant the ureter of the single kidney into the loin, where it is made to open on the surface of the body, and the urine is discharged into a suitable urinal.

The palliative treatment of extroversion consists in adapting some hollow cup-shaped appliance to the part in order to prevent the irritation from friction and collect the urine; but none that have been hitherto devised have proved very satisfactory.

Hypertrophy of the bladder.—The muscular coat of the bladder is frequently found to be hypertrophied after death, when there has been any cause which has obstructed the exit of the urine. Thus it is found in cases of stricture of the urethra, enlarged prostate, tumours of the bladder, stone in the bladder, and in chronic cystitis, where the thick ropy mucus which is formed causes considerable obstruction to the passage of urine. The hypertrophy produces a fasciculated condition of the wall of the bladder; the muscular tissue forming bundles of fibres, which interlace with each other and produce ridges on the mucous surface. In some instances, where the obstruction is great, the mucous membrane may bulge between these hypertrophied muscular bundles, and thus a condition of sacculation may be produced, when pouches or sacculi are formed, communicating with the interior of the bladder, and composed of the mucous and submucous coats only (fig. 362). Urine may be retained in one of these pouches, and may putrefy, giving rise to serious trouble, or a stone may become lodged in one of them (fig. 363). Hypertrophy of the

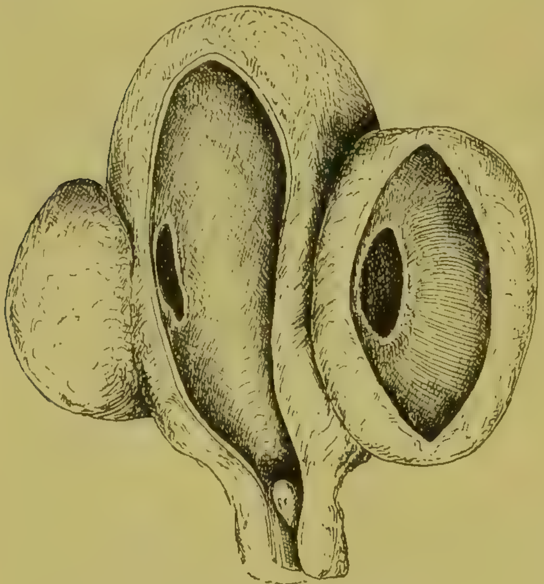

FIG. 362.—Sacculation of the bladder. (From a preparation in the Museum of St. George's Hospital.)

bladder may be attended with dilatation or not. In those cases where there is obstruction, but the muscular coat is sufficiently strong to overcome this obstruction, no dilatation takes place; in fact, in these cases the bladder is usually contracted, because there is always a certain degree of irritability, and the water is therefore passed frequently and the bladder never allowed to become normally full. But in those cases where the increased muscular power is not always sufficient to overcome the obstruction, and where, therefore, the patient suffers at times from over-distension, dilatation with hypertrophy will be found. Occasionally it happens that after death a bladder will be found to be dilated with little, if any, hypertrophy. This condition is confined almost entirely to obstruction from enlarged prostate, especially enlargement of the middle lobe, which, acting as a sort of valve, closes the orifice of the urethra and prevents the flow of any urine until the bladder becomes over-distended, when the stretching of the neck of the bladder renders the valve incompetent, and the water can be passed without increased muscular effort until the valve becomes again efficient.

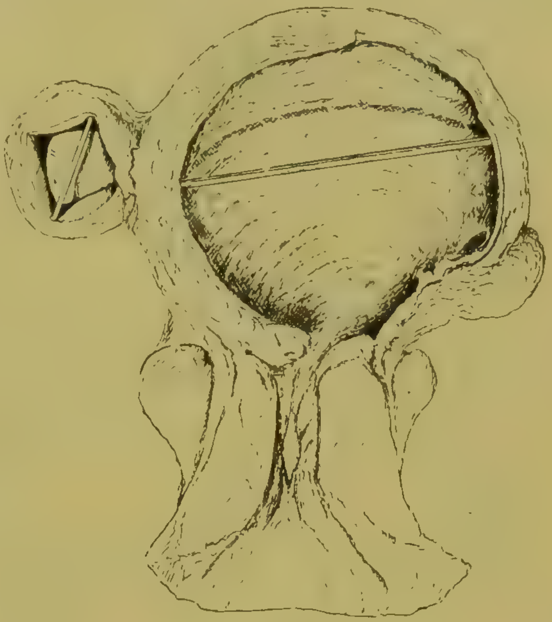

FIG. 363.—Calculus lodged in a pouch or sacculus of the bladder. (From the Museum of St. George's Hospital.)

Inflammation of the bladder.—Cystitis may be acute or chronic.

Acute cystitis may result from septic causes: the invasion of the bladder by septic organisms, which may be introduced through wounds, either surgical or otherwise; or may be introduced by a dirty catheter; or may find their way into the bladder from a gonorrhœa or urethritis. Inflammation of the bladder may also arise in gouty subjects from excess of uric acid, or from the presence in the urine of certain drugs, as cantharides and turpentine.

The **pathological changes** which are to be observed are that the mucous membrane becomes swollen and uneven, and of a crimson colour; the colouration being most marked in the neighbourhood of the trigone, where it is dark crimson, approaching to black. Occasionally the mucous membrane may be ulcerated in small patches, exposing the muscular coat; and in the later stages the muscular coats may be infiltrated with inflammatory products.

Symptoms.—There is pain in the perineum and hypogastric region, the pain in the latter situation being increased by pressure. There is extreme irritability of the bladder, and a constant desire to pass water. As soon as a few drops of urine accumulate in the bladder, the patient is seized with an irresistible desire to void it, and does so by a painful and spasmodic effort; the pain towards the end of the act being sometimes agonising.

The urine is scanty, high-coloured, alkaline, and contains pus and usually blood, so as to resemble prune-juice. There is usually a certain amount of fever, but it is not often very great unless some complication has arisen, such as an extension of the inflammation up the ureters to the kidneys. In rare cases the constitutional symptoms may be very severe, and the patient then rapidly sinks into a hopeless typhoid condition, with low muttering delirium, and dies with symptoms of acute septic poisoning.

Treatment.—The patient should be confined to bed, and great relief will be afforded by a hot bath twice a day, and by hot fomentations to the hypogastric region and perineum. If the strangury is severe, morphia suppositories or henbane in a saline draught should be administered. Plenty of diluent drinks, barley water, &c., should be given, and the diet should consist of beef tea and milk; all irritating articles of food and all stimulants should be interdicted. If the urine becomes foul and stinking, the bladder may require to be washed out, but it is better in these acute cases to avoid all passage of instruments, if possible; and if there is much strangury which does not yield to treatment, it is better to perform a perineal cystotomy and drain the bladder.

The symptoms of acute cystitis usually subside in the course of a few days, and the disease will assume a chronic form or will disappear altogether.

Chronic cystitis is much more commonly met with than the acute variety of the disease. It frequently follows the acute form, the more active symptoms subsiding; or it may be chronic from the first, arising very much from the same causes which were enumerated as producing acute cystitis. In cases of stricture of the urethra and stone in the bladder, chronic cystitis is sure, sooner or later, to be set up. It is also a common sequel of gonorrhœa, and may then be very persistent. It also arises from anything which may cause the urine to be retained in the bladder and become decomposed, as enlarged prostate, atony, paralysis from injury or disease of the spine. It is also set up in tuberculous disease of the bladder.

Pathological changes.—The mucous membrane of the bladder becomes thickened, swollen, and soft, and of a dark purplish or slate-coloured hue. Its epithelium undergoes a mucoid softening, and the surface becomes raw and ulcerated, and sometimes covered with a membrane which resembles a diphtheritic exudation, on which phosphates are deposited. Occasionally small abscesses, the size of a pea, are found in the substance of the mucous coat; and, again, in some cases portions of the mucous membrane desquamate and are passed per urethram; and in rare instances actual sloughing of the mucous membrane takes place. The submucous coat is commonly thickened and infiltrated with inflammatory products. The muscular coat undergoes changes, probably more from the causes which gave rise to the cystitis than from the cystitis itself; it is usually hypertrophied and fasciculated, but in those cases where obstruction has been due to some cause which no amount of increased force could overcome (see page 953), the bladder is dilated and its muscular coat is thinned and atrophied, and there is a large excess of fibrous tissue among its fibres. In cases of chronic cystitis, there is an abundant secretion of alkaline mucus from the surface of the bladder. This mixes with the urine and lessens its acidity, and decomposition is set up by the presence of a ferment, the *micrococcus ureæ*, which is present in the bladder; or by some bacteria admitted from without, either by means of a catheter or through the agency of the mucus which collects in the urethra. In consequence of this decomposition the urea is split up; the urine becomes fœtid and ammoniacal; and a vicious circle is set up, which renders the cystitis very intractable.

Symptoms.—The symptoms are very much the same as in the acute form of the disease, but less severe. There is frequent desire to pass water; pain before and during the act of micturition; and the urine contains mucus and pus. In consequence of the inflamed condition of the mucous membrane, the bladder is very irritable and is unable to retain more than a very limited amount of water, and the calls to micturate are urgent and frequent. The pain is especially great before the act of micturition is commenced, and if there is any delay, is often very severe indeed. The amount of pus or muco-pus in the urine varies. It is usually most abundant towards the end of the act of micturition. If the urine passed is allowed to stand, it sinks to the bottom of the vessel, where it forms a tenacious stringy sediment of muco-pus, mixed with epithelium and crystals of triple phosphates and granular phosphate of lime. The urine is alkaline, has a strong, offensive odour, and if means are not taken to prevent it, becomes abominably fœtid and offensive. In those cases where the urine contains blood in addition to these other abnormal constituents, ulceration is indicated. There is pain on pressure in the hypogastric region and in the perineum, and where the pain on pressure is very severe there is also a probability that there is ulceration. There is usually little or no pyrexia; but the pain, the interference with rest and sleep from the constant calls to pass water, and the absorption of septic products from the bladder, undermine the health, and may lead to death from exhaustion. In other patients the inflammation may extend up the ureters to the kidneys, and a condition of pyelo-nephritis be set up.

Treatment.—The treatment of chronic cystitis consists in the first instance in endeavouring to ascertain and remove the cause: if there is a stone or foreign body in the bladder it must be removed; if there is a stricture of the urethra it must be dilated; if the cystitis is due to retention of some portion of the urine from an enlarged prostate, a catheter must be passed and the bladder emptied at regular intervals. The local treatment must consist in daily irrigation of the bladder with some antiseptic solution. Great care must be observed in doing this: the catheter must be aseptic, so as to avoid the admission of micro-organisms from without; no force must be employed in introducing the fluid; only a small quantity must be injected, and a weak antiseptic must be used. Many different solutions are recommended; among the most useful are the following: boro-glyceride (ʒij to Oj); boracic acid (gr. xx to ℥j); Condy's fluid (ʒj to Oj); solution of corrosive sublimate (1 in 5,000); quinine (gr. ij to ℥j); and iodoform in mucilage (gr. iv to ℥j).

The mode of proceeding is as follows: A red-rubber catheter is the most suitable; this should be carefully sterilised and lubricated with carbolic oil (1 in 20), and gently passed. To the end of the catheter a piece of india-rubber tubing three feet long should be attached, with a funnel connected to its other end. The funnel is then raised till the tubing is tense, and two or three ounces of the solution selected, at a temperature of 100° F., should be poured into it and allowed gradually to find its way into the bladder by gravitation. As soon as all the fluid has found an entrance, the funnel is depressed between the patient's thighs, and the fluid allowed to run out. The funnel is then elevated again, and a fresh amount of fluid introduced, and this process is continued until the solution comes back perfectly clear. On no account should more than three ounces be introduced at a time. While this local treatment is being carried on, constitutional measures must be adopted. It will very much facilitate recovery if the patient is confined to bed, and kept at rest and in an equable temperature. The diet should be light, a milk diet being especially indicated, and no stimulants should be allowed. If the urine is alkaline and very fœtid, salol or benzoate of ammonia should be given internally. Formerly buchu, pareira brava, and uva ursi were extolled in the treatment of these cases. They do not appear to have any very decided influence; probably buchu is the most useful of the three, but when given should not be in a smaller quantity than a pint of the infusion each day. If the pain and other symptoms continue in spite of this treatment, or if the patient's general health begins to fail from septic absorption and broken rest, a perineal cystotomy should be performed, so as to give the bladder physiological rest for a few weeks. This treatment is often followed by the most satisfactory results, after all other measures have failed.

Perineal cystotomy.—The patient is placed in the lithotomy position, and a staff with a median groove is introduced into the bladder. An incision an inch and a half in length is made in the central raphé of the perineum, terminating about half an inch in front of the anus, and the various structures divided until the triangular ligament is reached. The point of the knife is now inserted into the groove in the staff by transfixing the membranous portion of the urethra, and the handle of the knife being raised, the instrument is pushed backwards and upwards along the groove into the bladder, dividing the prostatic urethra and a part of the prostate gland. The finger is introduced into the bladder by the side of the staff, and the bladder explored. A lithotomy tube is now passed through the wound into the bladder, and tied in. To the other end of the tube some india-rubber tubing is connected, which is carried to a utensil under the bed containing some solution of carbolic acid or other antiseptic, and by a siphon-like action the bladder is kept constantly empty.

Tuberculous disease of the bladder is most frequently secondary to tuberculous disease elsewhere: either in the testicle, when it spreads up the vas deferens to the vesicula seminalis, and so infects the bladder; or in the prostate, when it rapidly spreads to the neighbouring viscus; or it may be the result of tuberculous disease of the kidney spreading down the ureter. Tuberculous disease of the bladder may, however, occur as a primary affection. It is much more common in the male than in the female, and occurs most frequently during the years of early adolescence.

It commences as a deposit of tubercle in the submucous tissue, which caseates and breaks down, and forms a ragged, undermined, and unhealthy ulcer. The mucous membrane around is red, and the tissues beneath the ulcer thickened and sclerosed. In rare cases the ulceration may extend through the bladder wall and form fistulous openings with the rectum or external surface; or in the female, with the vagina.

The **symptoms** are those of chronic cystitis in the early stage, and the disease is often treated as this, unless some tuberculous disease elsewhere —e.g. in the testicle—suggests its nature. Later on, the intense irritability of the bladder, the great pain on pressure over the hypogastric region, and the presence of blood in the water will suggest ulceration; and the demonstration of the tubercle bacillus in the urine will at once establish the diagnosis.

Treatment.—In the early stages of the disease, local treatment is not of much use, and reliance must be placed simply on constitutional remedies. If practicable, the patient should be sent on a sea voyage, or at all events reside at the seaside, a dry warm climate being selected, and he should be out in the open air as much as possible. He should be warmly clothed in flannel, so as to promote the action of the skin, and his diet should be nourishing but unstimulating. I have found considerable benefit to arise in these cases from the internal administration of iodoform; a grain in the form of a pill with extract of gentian, given three times a day, will in some cases do great good. Cod-liver oil should also be given. Later on, when there is intense pain and constant calls to pass water, a supra-pubic cystotomy should be performed and the ulcers scraped with a sharp spoon, so as to remove as much as possible of the tuberculous material, and disinfected with pure carbolic acid; the bladder should then be drained. Drainage by perineal section often gives the greatest relief, but does not afford the surgeon so good an opportunity of dealing locally with the ulceration.

Tumours of the bladder may be innocent or malignant.

I. The **innocent tumours** of the bladder are (1) myxoma, (2) fibroma, (3) myoma, (4) dermoid, and (5) papilloma. All these, with the exception of the last, are very uncommon. 1. The **myxoma** resembles in structure the ordinary gelatinous polypus of the nasal fossa, and grows from the mucous surface. It never attains a large size, and is found only in children. 2. The **fibroma** grows from the submucous connective tissue, and consists of ordinary fibrous connective tissue. It is a solid growth, but is often papillated on its surface, as, indeed, are all tumours of the bladder. It may attain a very considerable size. 3. The **myoma** is an outgrowth of the muscular coat of the bladder, and consists of unstriped muscular fibre, with a varying amount of connective tissue. It does not as a rule attain a large size, and spring from the wall of the bladder by a broad base. 4. **Dermoid** is the rarest of all innocent tumours of the bladder. 5. **Papilloma** or **Villous tumour** of the bladder is the most common form of non-malignant growths of the bladder; though structurally it must be classed among the innocent tumours, it may nevertheless cause death from hæmorrhage. Like other papillomatous tumours, it consists of a number of processes; each process being made up of a capillary loop in a fibrous network, covered by a basement membrane and a more or less thick layer of epithelial cells. It resembles to the naked eye the appearance of the villi of the chorion, consisting of a number of long slender processes or villi, which, when immersed in water, float out and may be likened to a sea anemone (fig. 364). These processes are very vascular, and bleed freely when injured. The tumours are often multiple, and grow most frequently from the trigone, especially from the neighbourhood of the orifices of the ureters.

Symptoms.—The symptoms of tumours of the bladder are painless hæmaturia, followed by irritability. In villous tumour, with which we are especially concerned on account of its more common occurrence, the bleeding at first is usually small in amount, and then as the disease progresses there is a sudden, copious flow of blood, which is not intimately mixed with the urine, but comes chiefly towards the end of the act of micturition. This may continue for some days and then cease. There is usually little pain, and it is merely the colour of the urine which excites the patient's attention; but sometimes the pain may be very severe when a portion of the growth is carried into the orifice of the urethra and becomes grasped by the sphincter. In these cases there may be complete retention. After a time the bleeding recurs, and attacks come on at irregular intervals. A severe attack may sometimes be excited by the passage of a catheter. As the disease advances, frequent desire to pass water, and other signs of irritability of the bladder, may set in.

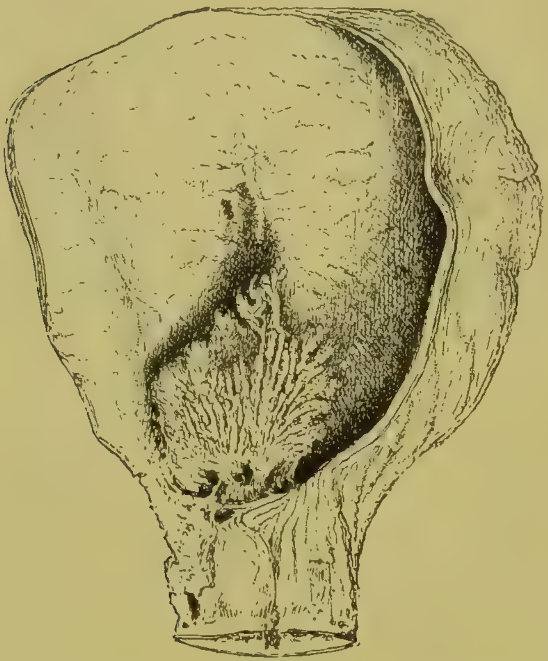

FIG. 364.—Villous tumour of the bladder. (From the Museum of St. George's Hospital.)

The **diagnosis** rests in these cases on the exclusion of other forms of hæmaturia, and especially on the recognition of portions of the growth under the microscope. Occasionally small particles become separated and are passed in the urine, or may be broken off by a catheter introduced into the bladder and brought away in its eye; and if the urine is examined carefully day by day, the surgeon will not fail eventually to find some of the growth. Examination by the finger in the rectum affords little assistance beyond helping to eliminate malignant disease as a source of the hæmorrhage. Of late years an additional means of diagnosis has been afforded by the use of the cystoscope; but this requires very great care and a practised hand for its management, as it is absolutely necessary that the fluid in the bladder during the examination with this instrument should be clear, and unless very gentle handling is carried out, hæmorrhage from the villous growth is likely to ensue, and the examination will then be impossible.

The **cystoscope** consists of a straight tube, with a short beak at its end, in which an electric light is placed, the wire connected with it passing down the tube. At the other end of the tube an eyepiece is inserted. Either on the concavity or convexity of the bend, according to the part of the bladder which is to be examined, is a window of rock crystal, and in the interior of the bend is a prism arranged in such a manner that the portion of the bladder wall illuminated through the window by the electric lamp is reflected down the tube on to the eyepiece. In using the instrument, a small quantity of clear boric solution should first be introduced, to prevent the mucous membrane of the bladder coming in contact with the heated beak of the instrument. The cystoscope may be used for diagnostic purposes in other cases besides those of villous tumour.

Treatment.—When villous tumour of the bladder has been diagnosed, its removal is indicated, since the prognosis is by no means good if this is not done, and the probabilities are that the growth will destroy the patient either from hæmorrhage or septic complications; or, like papillomata elsewhere, from the growth taking on a malignant form. The tumour may be reached by the perineum, or by an incision above the symphysis pubis. The latter is the better way, for not only can a distinct view of the tumour be obtained, but there is more room in which to work; and in a subject with a deep perineum or enlarged prostate it is exceedingly difficult to reach the tumour with the finger in the perineal operation. The ordinary supra-pubic cystotomy is first performed, and after the bladder has been opened, the parts are well retracted or an expanding speculum introduced, and by means of an electric lamp a light is thrown into the bladder and the tumour can be thoroughly investigated. The growth may then be torn or twisted off by forceps specially devised by Sir Henry Thompson for this purpose (fig. 365), or may be burnt away with the actual cautery. Perhaps the best way is to combine the two—to tear away as much of the growth as possible with the forceps, and then cauterise the surface from which it sprang.

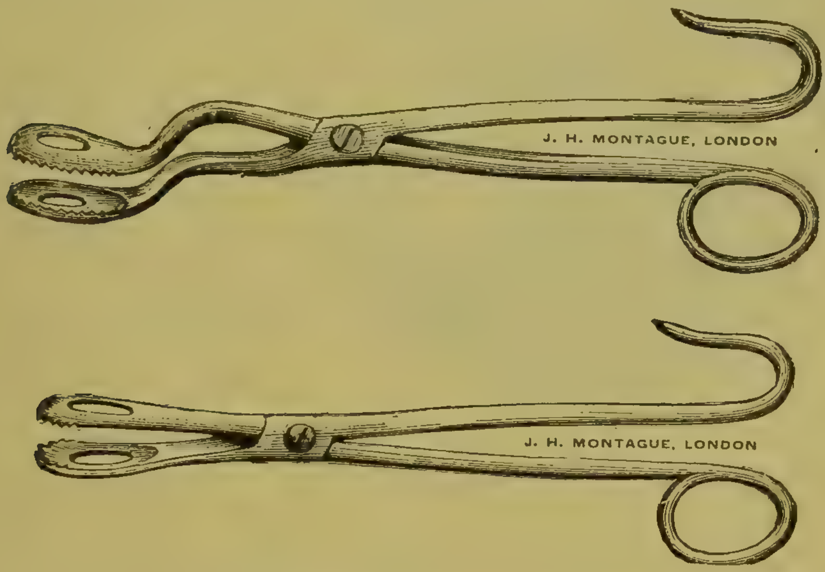

FIG. 365.—Thompson's forceps for removing growths from the bladder.

II. **Malignant tumours** of the bladder.—Malignant tumours of the bladder may be either primary or secondary, more commonly the latter; spreading from the rectum or prostate in the male, or the vagina and uterus in the female. In these cases the nature of the growth is the same as that of the primary tumour; for instance, where it is the result of primary rectal cancer it is of the nature of columnar epithelioma. Primary malignant disease of the bladder is usually of the nature of squamous epithelioma, though cases of sarcoma, either round-celled or spindle-celled, and rarely lympho-sarcoma, do occur. The disease almost always attacks the posterior wall of the bladder and infiltrates its coats, and rapidly ulcerates (fig. 366), the surface of the ulceration becoming incrusted with phosphatic deposit, which greatly adds to the patient's sufferings. Occasionally the ulceration may perforate the resto-vesical septum and form a recto-vesical fistula; but this more often occurs in those cases where the primary disease is in the rectum. In some instances, instead of the growth infiltrating the walls of the bladder, it projects into the vesical cavity and does not invade the muscular coat till later. There seem to be some grounds for believing that these cases may be really papillomatous tumours, which have become malignant.

Symptoms.—The symptoms of the true infiltrating cancer of the bladder differ from those of innocent tumours, in the fact that pain and increased desire to pass water usually set in before the patient begins to pass blood. As soon, however, as the tumour begins to ulcerate, blood is passed, especially towards the end of the act of micturition, and this is accompanied by intense pain in the hypogastric region, in the perineum, and at the end of the penis. The urine becomes alkaline and putrescent, and shreds of the growth may be passed by the urethra, in which, upon microscopic examination, the typical anatomical characters of epithelioma may be recognised. Occasionally the growth may invade the orifice of the urethra, and obstruction may ensue. In those cases where a recto-vesical fistula forms, the sufferings of the patient are very considerably aggravated by some of the fæces finding their way through it into the bladder. The disease is rarely met with under the age of forty, and is more common in the male than in the female. It is rapid in its course, and death usually occurs from exhaustion, or from the spread of septic troubles to the kidneys. In the superficial form of the disease, alluded to above, the symptoms are identical with those of villous tumour—painless hæmorrhage coming on without assignable cause at irregular intervals—and it is not till later that the symptoms of the true infiltrating cancer show themselves.

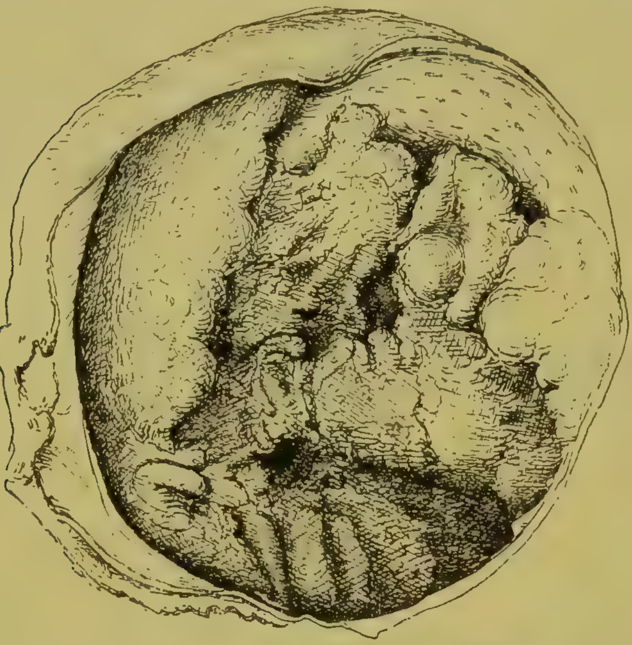

FIG. 366.—Malignant tumour of the bladder. (From the Museum of St. George's Hospital.)

The **diagnosis** of malignant tumours of the bladder from innocent growths is to be made by the rapid progress of the disease; the intensity of the patient's sufferings; the examination of portions of the growth passed per urethram; by the cystoscope, and by examination with the finger per rectum. In malignant disease the infiltrated walls of the bladder can generally be felt, whereas in villous growths no tumour can be detected.

Treatment.—Little or nothing can be done, from a curative point of view, in these cases. Before the disease is diagnosed, it has usually progressed so far that removal is out of the question; or if an attempt is made and the growth removed, a recurrence is almost certain to take place. Palliative treatment consists in keeping the bladder at rest by means of a perineal cystotomy, and this should be done if the symptoms of cystitis are severe or the pain and hæmorrhage great; otherwise it only remains to soothe the patient's sufferings by morphia.

FUNCTIONAL DERANGEMENTS OF THE BLADDER

Irritability of the bladder.—By this term is meant a frequent desire to pass water, not depending upon an increase in the quantity secreted. It varies much in degree: in some persons there is naturally a disposition to pass water more frequently than in others; and in some the habit has gradually grown to such a degree that the patient is constantly micturating. Irrespective of these cases there is a condition of irritability which is set up by disease in the urinary organs or elsewhere.

The **causes** which may give rise to irritability of the bladder are very numerous: such as (1) the excess of lithic acid or lithates in the urine; it is therefore very common in the gouty subject; (2) disease of the kidney, and more especially tuberculous disease, and, to a less extent, stone in the kidney: (3) cystitis and stone in the bladder, or the presence of a tumour or foreign body; (4) inflammation or tuberculous disease of the prostate; (5) diseases of the rectum or anus, such as fissure, piles, or the presence of ascardies in the rectum.

Treatment.—In treating these cases the cause must be sought for, and removed if possible; and when this is done the symptom of irritability will probably subside of itself. There are, however, some cases in which no cause can be found for the condition, and in which the patient's life is rendered miserable by the constant and almost uncontrollable desire to pass water. Under these circumstances, relief may sometimes be given by performing a perineal cystotomy and giving physiological rest to the bladder for a short time.

Incontinence of urine.—By this term is meant that condition where the urine escapes involuntarily, and its retention is not under the control of the will. The escape may be either continuous, the urine constantly dribbling away as fast as it enters the bladder; or it may be intermittent, the escape taking place only occasionally, most frequently at night. It may be of two kinds, either Active or Passive.

Active incontinence is particularly common in young children, especially in boys, and is not constant, occurring only at night. It arises in many cases from an irritable condition of the urinary organs, engendered by the presence of ascarides in the rectum; a rectal polypus; a tight foreskin: or by the presence of excess of lithic acid in the urine. It may also be caused by insufficient power in the sphincter vesicæ, so that the patient loses control over it during sleep.

The **treatment** consists in removing any source of irritation which may exist; in improving the patient's general health by the administration of tonics, especially strychnia and iron, fresh air and carefully regulated diet. Belladonna also may be given internally, and appears to exert some influence in checking the incontinence. Finally, the child should be awakened at stated hours during the night, and should be made to get up and pass water, which will often do much to break him of the habit. In some cases, however, no treatment seems to be of any avail, and the habit may remain until adult life is reached.

Passive incontinence is that condition where there is entire loss of control over the bladder, so that the water dribbles away as fast as it finds an entrance into the bladder. This condition is usually due to paralysis of the sphincter, from loss of nerve influence owing to some lesion of the nerve centres; but in the female may be due to over-dilatation of the urethra, for the purpose of digitally exploring the bladder or removing a stone, especially if the dilatation has been performed gradually. With regard to the treatment of these cases nothing can be done, beyond providing the patient with a urinal, which will have to be worn night and day. They must not be mistaken for distension of the bladder with overflow, which may arise from paralysis of the detrusor urinæ (see page 749), or from enlargement of the middle lobe of the prostate, which forms a sort of valve and prevents the passage of water until the bladder is full, so that its neck becomes dilated and the valve inefficient. The diagnosis is made by examining the hypogastric region, when the distended bladder will be at once detected.

Atony of the bladder is a term used to imply inability on the part of the patient to empty his bladder, not because it is paralysed, but because the muscular coat has lost its power of contracting, from loss of tone. This loss of tone may be due to several causes. It may be due to (1) an acute active over-distension of the viscus. A patient either voluntarily or compulsorily retains his water for too long a period, and when he attempts to pass it, finds that he is unable to do so because the muscular coat of the bladder, from having been overstretched for too long a time, has lost its power of contracting. (2) It may be due to a more gradual and chronic distension of the organ, as in cases of stricture and prostatic disease. In consequence of the obstruction to the passage of the water caused by these diseases, the bladder is not able to completely empty itself, and a small quantity is retained after micturition; the amount gradually increases, as the muscular fibres lose their tone and the bladder becomes distended. This condition generally arises in the old and feeble, in whom no compensatory hypertrophy of the muscular coat takes place. (3) Atony of the bladder may follow cystitis in those cases where the inflammation has spread to the muscular coat and produced fibroid or fatty changes in it. (4) Finally, it occurs in old age, from loss of nerve tone and senile degeneration of the muscular coat of the bladder.

The **treatment** in these cases must depend upon whether the condition is due to a single over-distension or to any of the other causes. The first class of cases are amenable to treatment; the others are practically incurable, and treatment can only be adapted to relieving the distension and preventing any evils arising therefrom. In cases of atony originating from a single over-distension, a catheter must be passed two or three times a day to empty the bladder. Tonics, especially strychnia, phosphoric acid, and iron, must be given, and galvanism applied two or three times a week. Where the atony is due to advanced age or to changes in the muscular coat, a catheter must be passed regularly twice a day, or oftener if necessary. The patient must commence what is known as 'catheter life,' and once having commenced it, will never be able to relinquish it. The object of this is to mechanically empty the bladder twice a day, so that no residual urine, which he is unable to expel, shall be left behind, as it would certainly undergo decomposition and set up cystitis. The patient should be taught to pass the instrument himself, so as to be entirely independent of outside aid.

Retention of urine.—When a patient is unable to pass his water, so that it is retained in the bladder and this organ becomes distended, *retention* is said to have occurred. It may arise from many different causes: (1) From inability of the muscular fibres of the bladder to expel its contents, from (*a*) paralysis due to injury or disease of the brain or spinal cord; (*b*) from loss of tone (atony); (*c*) from reflex paralysis, often occurring after injury or surgical operations, especially that for hæmorrhoids; (*d*) from hysteria. (2) It may arise from obstruction to the outflow of urine from the bladder: (*a*) from pressure of tumours; (*b*) from stone or tumour in the bladder; (*c*) from abscess of or enlarged prostate; (*d*) from stricture, ruptured urethra, phimosis, or stone in the urethra, &c. In the old man it is generally due to enlarged prostate, which from exposure to cold has become congested and swollen; in the adult man, to stricture, to which spasm may be superadded; in the adult woman, to uterine causes; in the young man to gonorrhœa, and in the young woman to hysteria; in the male child it is usually due to stone in the urethra, or to phimosis; at all ages and in both sexes it may be due to reflex spasm from irritation about the rectum or anus.

When it is due to paralysis or atony of the bladder, after the bladder has become over full, it will overflow, and incontinence with distension will ensue. When it is due to stricture of the urethra, the dilated urethra behind the stricture may rupture and extravasation of urine result, or in some cases even the bladder may give way (see Stricture of Urethra). When it arises from other causes, the retention can usually be relieved by appropriate treatment before any untoward consequences result.

The treatment will be discussed in connection with the various conditions which give rise to retention.

STONE IN THE BLADDER

Stone in the bladder is produced by the aggregation of some of the ordinary urinary deposits. Formerly it was supposed that there was some definite diathesis connected with the formation of different calculi, but this is believed now not to be so; but at the same time a knowledge of the character of these deposits is necessary for the successful treatment of the disease, and often affords valuable information as regards irregularities in assimilation.

The various deposits in the urine may be divided into two classes: those derived from the organic constituents of the urine and which are allied to the urates, and those derived from the inorganic salts, the phosphates, and the carbonates.

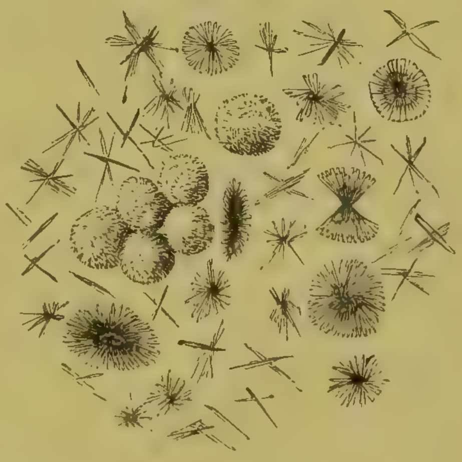
FIG. 367.—Urate of ammonia crystals. (From 'A System of Surgery,' by Holmes and Hulke.)

The *urates* or lithates of ammonia and of soda are the most common. They form a precipitate in cold urine, which disappears upon the application of heat. The precipitate is usually of a yellowish-red colour, and gives to the urine a semblance to pea soup; but at other times it is purplish or almost white. Under the microscope it appears as an amorphous deposit, or as minute globular masses with acicular spiculæ protruding from them (fig. 367). They are very common, and may occur in a condition of health, especially in cold weather and after violent and prolonged exertion. They are found also in all febrile conditions which are associated with increased waste of the tissues of the body. Their habitual presence indicates disorder of the digestive or cutaneous functions.

Uric acid is deposited in the form of crystals, which appear as small red grains in the urine, and may be likened to cayenne pepper. These crystals do not dissolve on the application of heat, but are readily soluble in weak solutions of potash or soda. Under the microscope they present several forms, the most common being smooth transparent rhombic plates and diamond-shaped acicular prisms (fig. 368). Golding Bird attributes the formation of uric acid deposits to the following causes: '(1) The waste of tissue being more rapid than the supply, as in fever, rheumatism, &c.; (2) the supply of nitrogen in the food being greater than is required for the reparation of the tissues, as in over-indulgence, especially in the use of animal food; (3) the process of digestion being insufficient to assimilate an ordinary and normal supply of food, as in dyspepsia; (4) obstruction to the cutaneous outlet for nitrogenous secretions, as met with in diseases of the skin, variability of climate, &c.; (5) congestion of the kidneys from injury or disease.'

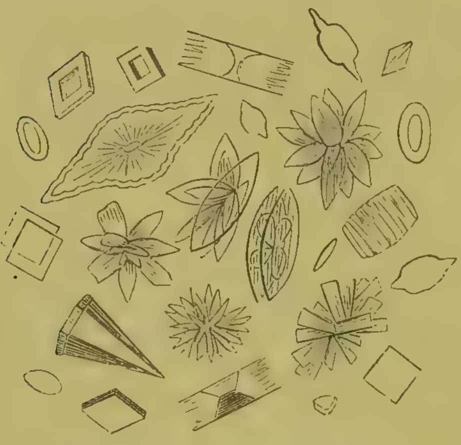

FIG. 368.—Uric acid crystals. (From Erichsen's 'Surgery.')

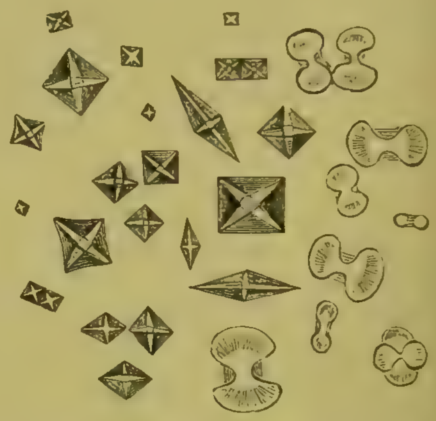

FIG. 369.—Crystals of oxalate of lime. (From 'A System of Surgery,' by Holmes and Hulke.)

Oxalate of lime is another common deposit in the urine. It is closely allied to uric acid—oxalic acid being supposed to be derived from uric acid by imperfect oxidation. Under the microscope it appears in two forms: as octohedral crystals and as dumb-bell crystals (fig. 369). The cause of oxalate of lime in the urine is uncertain; it occurs in cases where there is indigestion, especially associated with the imperfect oxidation of the carbohydrates taken as food, or from taking too much fermented liquids. Certain articles of diet, as rhubarb, will also cause its presence in the urine.

Xanthic oxide and *cystic oxide*, or *cystine*, are rarer forms of deposit derived from the organic constituents of the urine. The latter is chiefly remarkable from containing a quantity of sulphur. It appears under the microscope as six-sided prisms.

The *inorganic* deposits are the phosphates and the carbonates. The *phosphates* are of three kinds: (1) The *phosphate of ammonia* and *magnesia* (triple phosphate) is found in decomposing urine, and is not associated with any special constitutional condition. It appears in the form of triangular prisms with truncated extremities (fig. 370). (2) The *phosphate of lime* is only deposited when the urine is alkaline, and forms a white cloudy mass, usually at the end of the act of micturition. When it occurs in the urine in excess, it is precipitated by heat and may be mistaken for albumen, but is speedily redissolved by the addition of acid. Under the microscope it is usually amorphous, but may sometimes be seen in the form of spherules. This condition is often associated with overwork and mental strain, and it also occurs in some forms of disease of the nervous system. (3) The *mixed phosphates*, consisting of a mixture of phosphate of lime, ammonia, and magnesia, are the form of phosphates met with in ammoniacal urine. They are insoluble in water, and when set free from their solution in the urine, which is done by the ammonia in the decomposing fluid, they are readily thrown down and deposited on any foreign body introduced into the bladder.

Carbonate of lime is now and then met with as a deposit in faintly alkaline urine; but it is doubtful if it ever forms a calculus, though it is said that it has sometimes been found forming a distinct stratum in a phosphatic stone.

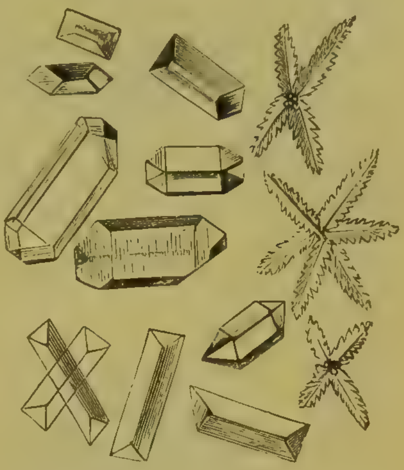

FIG. 370.—Crystals of ammonio-magnesian phosphate. (From 'A System of Surgery,' by Holmes and Hulke.)

The various kinds of calculi correspond to the deposits, and the three most common forms are the uric or lithic acid, the oxalate of lime, and the phosphatic.

Uric acid calculus is ovoid or round, of a fawn or reddish-brown colour. Its surface is generally fairly smooth or slightly warty. On section it is laminated, and the cut surface is susceptible of a high polish. It is hard but brittle, and when broken separates into sharp fragments. It is insoluble in hydrochloric acid; soluble in caustic potash or ammonia. It disappears in the blowpipe flame; with nitric acid and ammonia it gives the murexide test. The **urate of ammonia** calculus is very rare, and is found only in children. It is whitish-grey in colour, and is earthy and inclined to crumble. On section, it is seen to be laminated, but the concentric rings are not so distinct as in the uric acid stone. It may be distinguished from it by heating it with caustic potash, when ammonia is given off, which is not the case with the uric acid calculus.

The **oxalate of lime** is very irregular and tuberculated, of a dark brown or even black colour, and is hence known by the name of the mulberry calculus, from its resemblance to this fruit. It is very hard and difficult to crush. It is soluble in hydrochloric acid, and does not disappear in the blowpipe flame. It is not soluble when warmed with alkalies, and effervesces after heating upon the addition of an acid.

The **mixed phosphate** is white or grey and chalky in appearance. It is smooth on the surface, friable, and easily broken down. The tests are the same as those for the mulberry calculus, except that it is soluble in acetic acid and fuses when heated. With nitric acid and ammonia it does not give the murexide test.

The **triple phosphate** very seldom forms a calculus by itself, but is not unfrequently deposited around any foreign body introduced into the bladder, as a catheter which has been tied in, or a stone, in cases where there is cystitis and the urine is decomposing. Phosphate of lime calculus is also very rare.

Calculi are most frequently formed originally in the kidney, and descend through the ureter into the bladder; but sometimes they originate in the bladder spontaneously, or are deposited around some foreign substance either introduced from without or around some organic matter, either fibrine or blood clot, contained in the bladder.

Growth.—Calculi in the bladder increase in size by the deposit on their surface of fresh material from the urine, and may sometimes attain an enormous size. This increase in size has a tendency to produce lamination, and the various laminæ of which they are composed may consist of different materials, according to changes in the composition of the urine at various times. That material which happens to be in excess in the urine at any given time is the one which is deposited on the stone. Thus a lithic acid stone may be formed in the kidney and descend into the bladder. After a time, it may be as the result of change in dietary or from some other cause, the lithic acid which has been in excess in the urine is imperfectly oxidised, and oxalate of lime is in excess instead, and the stone increases by the deposit of oxalate of lime upon it. Later on, cystitis is set up, the urine decomposes and becomes alkaline, and then the calculus becomes coated with successive layers of phosphates. To such stones as these, the name *alternating calculi* is given (fig. 371).

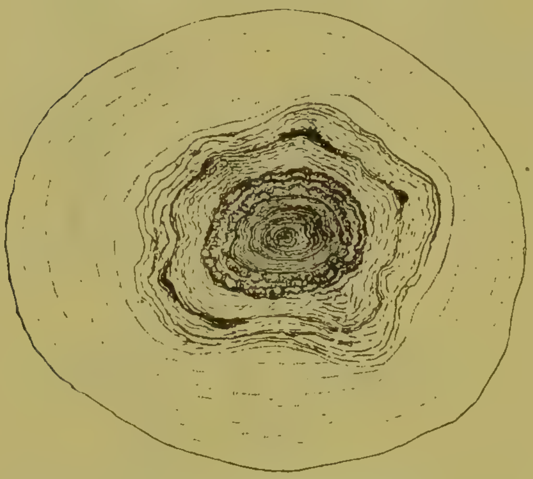

FIG. 371.—Alternating calculus. (From the Museum of St. George's Hospital.)

Calculi are much more common in the male than in the female. This may be partly due to the greater dilatability and shortness of the female urethra, so that stones in the bladder are more easily passed and got rid of; but independently of this there seems no reason to doubt that stone occurs more frequently in the male than in the female. They are most common either during childhood or in advanced life, being most frequently present in children among the poorer classes, and in old age among those who are well-to-do. To a certain extent they may be regarded as hereditary, certainly as regards the cystic oxide calculus; with regard to other forms the hereditary tendency is not so marked. They are far more common in some parts of England than in others, and in some foreign countries, as the North-West Provinces of India, than in any part of England. The reason of this is not at present very apparent; in fact, the cause of stone is at present unknown.

Symptoms.—The symptoms of stone vary within certain limits, according to the size and roughness of the stone, and as to whether it is free or encysted. The three main symptoms are pain, increased frequency of micturition, and hæmaturia.

1. The pain is of two kinds. There is a sharp cutting pain towards the close of or immediately after micturition, especially referred to the end of the penis. This is produced by the contraction of the bladder, causing the sensitive mucous membrane to rub against the stone. In cases where the stone is encysted or lies in a pouch behind an enlarged prostate this pain is absent. In young children it is frequently well marked, and is evidenced by a tendency on the part of the child to pull upon the prepuce and produce elongation of this structure. Secondly, there is a constant chronic pain, and sensation of weight and heaviness in the region of the bladder and perineum, and if the stone is large this pain radiates down the back of the thighs, from mechanical pressure on the sacral plexus. Pain is much increased by exercise, especially riding or driving, and is relieved by the recumbent position.

2. There is increased frequency of micturition. This is especially marked during the day while the patient is moving about, and more particularly if he is subjected to jolting and shaking, so that it sometimes renders horse or carriage exercise impossible. During the night, when he is at rest in bed, the stone remains in one position, and then this symptom is but slightly marked or may be altogether absent. In this it presents a marked difference to the frequency of micturition in enlarged prostate, which is always worse when the patient is warm in bed.

3. Hæmorrhage.—In cases of stone in the bladder there is always the history of the passage of blood at some period of the case, though it is not always constant, and may be absent for some considerable time. It is chiefly noticed after exercise or exertion, and frequently disappears if the patient remains quiet in bed. It generally shows itself in the passage of a few drops of bright blood after the act of micturition has been completed, and is caused by the walls of the bladder becoming bruised when they come in contact with the stone.

In addition to these principal symptoms other subsidiary ones may exist. There may be the history of the sudden arrest of the flow of urine during the act of micturition. This is caused by the stone being carried to the neck of the bladder and occluding the orifice of the urethra. Sometimes the patient will further inform the surgeon that when this has occurred he has found, from practical experience, that by lying down he is able to complete the act. When he does this the stone rolls away from the orifice of the urethra, and the impediment to the outlet of the water is removed. In children, as already mentioned, the prepuce is elongated, and, as there is often a good deal of straining, prolapsus of the rectum in children, and piles in the adult, are very common conditions met with in cases of stone in the bladder. Sooner or later cystitis will be set up, and then there is an aggravation of the symptoms. The frequent desire to pass water is increased, and torments the patient by night as well as by day. The urine first becomes loaded with mucus, and then alkaline, and finally contains blood and pus. The kidneys become involved, pyelo-nephritis is set up, and the patient succumbs partly from exhaustion and partly from septic poisoning. In those cases where the stone is encysted (fig. 363), many of the foregoing symptoms are absent. There is no sharp cutting pain at the end of micturition, there is no blood in the urine so long as cystitis is not set up, and there is no sudden stoppage in the act of micturition. There is, however, constant dull aching pain in the region of the bladder and perineum, and there is frequent desire to pass water, from the irritation produced by the presence of the stone. Although all the foregoing symptoms are present and well marked, the surgeon is not justified in positively pronouncing the opinion that a stone is present without sounding the bladder. This is done by introducing a sound—a solid steel instrument, shaped like a catheter, but shorter in the beak—into the bladder and making it strike against the stone. By this means the stone can be felt, and generally heard clicking against the sound. The patient should be laid on his back with a pillow under the pelvis, and the surgeon should stand on his right side. If the water is not clear, the bladder should be washed out with a little boric acid solution, and a few ounces afterwards left in the bladder. The sound is then passed, and by moving it in different directions it is made to strike against the stone. This will produce a sharp click, which can generally be heard by the bystanders, and will convey a rough grating sensation to the surgeon's hand, which is unmistakable. By moving the beak of the sound over the stone, an approximate idea of its size and degree of roughness may be obtained. In sounding for stone the surgeon should not be satisfied unless he can assert that he positively feels the stone; if he only *thinks* that he feels it, in all probability no stone is present. In some cases a stone may be in the bladder, and still the surgeon may not detect it. It may lie behind an enlarged prostate or behind the pubes, so that the sound cannot easily reach it, or it may be contained in a sac which communicates with the bladder by a small opening. If this is the case an examination may be made with the cystoscope, or the evacuating tube used in lithotrity may be passed and the bladder distended with Bigelow's evacuating bottle. When the pressure is removed from the bottle it expands, and the fluid rushes into it from the bladder, and carries with it the stone, which strikes against the tube and produces a distinct sound. In male children a stone in the bladder may sometimes be felt by the finger introduced into the rectum.

Treatment.—The treatment of vesical calculus consists in removing the stone by the operation of (1) lithotomy or (2) lithotrity.

1. **Lithotomy.**—The operation of lithotomy consists in cutting into the bladder where it is uncovered by peritoneum, and removing the stone. The ways in which this can be done are numerous, but the two operations most frequently adopted are lateral lithotomy and the supra-pubic operation. Space will not allow of doing more than describing these two operations.

Lateral lithotomy.—The perineum having been shaved, if necessary, and suitably prepared, an enema is given an hour or two before the operation so as to empty the lower bowel; the perineum is then again cleansed and packed. After the patient has been anæsthetised, he is drawn to the edge of the table, so that the buttocks slightly project over it, and the bladder is washed out, five or six ounces of antiseptic solution being left in. The staff is now passed and the stone felt. Various forms of staff are used by different surgeons, but the curved staff of the shape of an ordinary catheter with the groove on its convex surface is the one ordinarily adopted (fig. 372). Some surgeons use a straight staff, because they assert that with it the knife is less likely to slip out of the groove; formerly a rectangular staff was employed. Some surgeons prefer a staff with a groove on one side instead of in the centre. Whichever instrument is used the surgeon should be careful to feel the stone with it, as a sure indication that it is in the bladder, and unless this can be done the operation should not be proceeded with. When the staff has been passed and the stone felt, the patient is placed in the lithotomy position, with the knees well apart and the sacrum flat upon the table, the patient's body being kept quite perpendicular to it. The staff is now given to an assistant to hold, and it should be held with the handle well depressed towards the patient's abdomen, so that the shaft of the instrument rests against the front of the symphysis pubis ; this brings the membranous portion of the urethra nearer the surface of the perineum. An incision is now made commencing on the left side of the median raphé of the perineum, one and a half inches in front of the anus, and carried backwards and to the left side to a point midway between the tuber ischii and the anus. The incision is gradually deepened until the operator can distinctly feel the groove in the staff with his forefinger introduced into the wound. The point of the knife is now introduced into the groove in the staff by transfixing the membranous portion of the urethra, and when the point is distinctly felt impinging against the steel, a sensation which will be perceived both by the operator and the assistant holding the staff, the handle of the knife is somewhat depressed and also lateralised, and the point pushed onwards until it reaches the bladder ; this will be known by all sense of resistance ceasing, and probably also by a gush of the fluid in the bladder taking place (fig. 373). In doing this the utmost care must be taken not to allow the point and back of the knife to leave the groove in the staff. If this accident should occur, the rectum may be wounded, or the loose cellular tissue between the rectum and the bladder may be opened up and the latter viscus never reached. In thrusting the knife onwards, the membranous portion of the urethra and the compressor urethræ muscle are divided ; the capsule and the left lobe of the prostate gland partially cut. When the knife has been felt to reach the bladder it is withdrawn, and in doing so the wound is slightly enlarged by depressing the knife against the

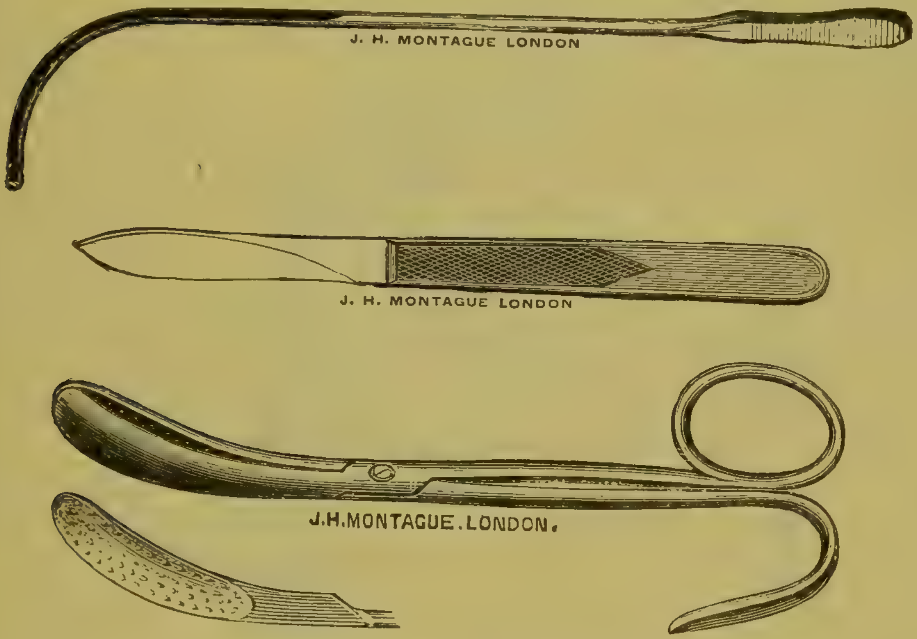

FIG. 372.—Grooved staff, lithotomy knife, and lithotomy forceps.

tissues. The forefinger of the left hand is now wormed along the convexity of the staff into the bladder and the stone sought for; when this is felt, the assistant is instructed to withdraw the staff, and the opening in the prostatic urethra and the neck of the bladder is dilated with the forefinger. If the stone is of large size, a blunt-pointed straight bistoury should be introduced along the finger into the bladder, and the right lobe of the prostate notched. This is a better plan than bruising and tearing the parts by endeavouring to extract too large a stone through too small an opening. After the opening has been dilated as far as is judged necessary, lithotomy forceps are to be introduced along the dorsum of the finger into the bladder, and when the blades have entered that viscus the forefinger may be withdrawn from the wound. As the finger is withdrawn, the fluid which is still retained in the bladder escapes with a rush, and will often carry the stone into the blades of the forceps if they are opened to receive it. If this does not happen, the stone must be felt for: the forceps are opened and the lowermost blade must be swept along the floor of the bladder by a turn of the wrist until the stone is felt, when it is at once grasped. When the stone has been caught, if it is of any size, the finger should be again introduced into the bladder by the side of the forceps to see if it is held in its shorter axis; if not, an endeavour must be made to alter its position as it lies in the grasp of the forceps. If this cannot be done, it should be let go and again seized. When grasped in the right position, it must be extracted by steadily pulling downwards and backwards in the line of the axis of the pelvis. This must be done with care and gentleness so as not to bruise and tear the neck of the bladder. The extraction will be facilitated by a rocking, side-to-side movement of the hand. Where the stone is small and difficult to seize with the

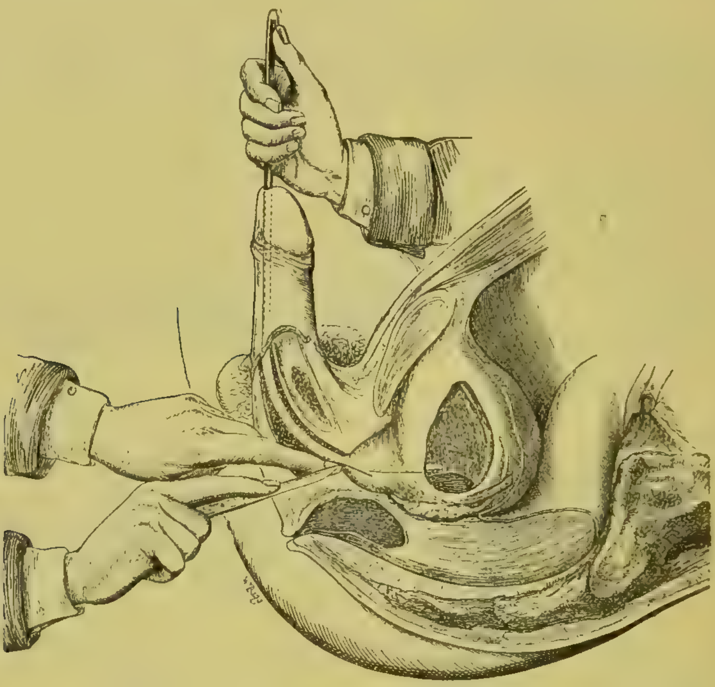

FIG. 373.—Anatomy, in section, of parts concerned in lithotomy. Position of hands in last incision. (From 'A System of Surgery,' by Holmes and Hulke.)

forceps, it can generally be extracted by a scoop, in which it is held by the tip of the forefinger. After the stone has been removed, the bladder must be carefully searched to see whether there is another stone. All hæmorrhage having been arrested, the patient is wrapped up in blankets and taken back to bed. It is advisable after the operation to introduce a lithotomy tube through the wound into the bladder and tie it in. By this means the bladder is kept drained, and the urine, at all events to a very great extent, is prevented from passing over the raw surfaces of the wound.

The after treatment consists in keeping the patient quiet and dry. An ordinary bottle urinal may be arranged so that the urine flowing through the tube may pass into it, and the wound should be packed round with wood wool padding. The diet should be light and unstimulating, and the patient should be encouraged to drink plenty of diluents. The wound should be washed out twice a day, and when it has begun to granulate the tube may be removed. The water will at first be passed entirely through the wound; but as it contracts the passage through the natural route will return, and there is usually no difficulty about the final closing of the wound, which generally takes place in about three weeks.

Complications.—There are numerous complications and accidents which may attend the lateral operation of lithotomy. 1. *Hæmorrhage* may arise from three sources: (*a*) either from the superficial vessels of the perineum, when it is easily dealt with; or (*b*) from wound of the artery of the bulb, or some other deep branch of the internal pudic. This is frequently very difficult to deal with; the artery must be seized with forcipressure forceps and tied if possible, otherwise the forceps must be left in the wound, compressing the vessel until they separate. In some cases where the vessel cannot be reached, it has been necessary to compress the internal pudic artery against the tuberosity of the ischium with the finger introduced into the wound. (*c*) Occasionally severe venous bleeding takes place from the prostatic sinuses, especially where the prostate is enlarged. In these cases dark venous blood wells up from the deeper parts of the wound, and the bladder may become filled with clots. The treatment in these cases is to plug the wound with a *tube en chemise.* This consists of a straight lithotomy tube, around which is tied about an inch from its extremity a piece of lint or gauze which forms a sort of bag or petticoat around the tube, which is then introduced into the bladder, and the space between the tube and the petticoat stuffed with gauze. This by pressure arrests the hæmorrhage, while the urine which is secreted escapes by the tube. An air tampon, if at hand, may be used instead. If the bladder becomes filled with clot, it must be broken up and washed away by syringing with hot solution of boric acid. 2. *Wound of the rectum.*—This may arise from the knife slipping out of the groove of the staff as it is thrust onwards into the bladder; or in children, in cutting too far backwards in withdrawing the knife. The accident is not always discovered at the time of the operation, and it only becomes evident upon the subsequent escape of flatus and fæces from the wound. When wounded by the point of the knife as it is thrust onwards, the opening in the gut is often small, and is situated just above the external sphincter, and under these circumstances may heal without difficulty. If, however, the opening is larger and higher up, a recto-urethral fistula is very apt to ensue. 3. The posterior wall of the bladder has been wounded by thrusting the knife too far onwards after reaching the bladder. 4. In young children there is always a danger of the urethra being torn across, and pushed before the finger into the bladder. This may be avoided by first introducing a pair of dressing forceps along the groove in the staff after the urethra has been incised, and by opening and withdrawing them, dilating the passage before an attempt is made to introduce the finger. 5. Another accident which is likely to arise from the knife slipping from the groove in the staff is that the bladder is never reached at all, but the loose connective tissue between it and the rectum is opened up. This is then broken down by the finger; and under the supposition that it is in the bladder, fruitless endeavours are made to find the stone.

Causes of death.—Death may result from shock, after a protracted operation, as in the case of a very large stone; it may occur from hæmorrhage; or from suppression of urine, where the kidneys are extensively diseased. Later on it may occur from diffuse septic inflammation of the pelvic cellular tissue leading to pyæmia. This arises in those cases where the recto-vesical fascia has been laid open, and the urine becomes infiltrated into the pelvic cellular tissue; and also where the areolar tissue about the neck of the bladder has been torn and bruised in the endeavour to extract a large stone. Septic cystitis is another occasional cause of death after lateral lithotomy, the inflammation extending to the kidneys and destroying life from septic pyelo-nephritis.

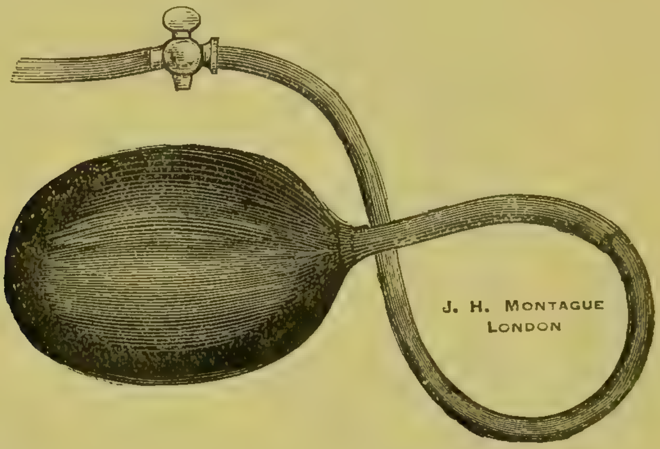

FIG. 374.—Petersen's bag.

Supra-pubic lithotomy.—The removal of a stone from the bladder by an incision through the anterior abdominal wall immediately above the symphysis pubis, and through the anterior wall of the bladder, where it is uncovered by peritoneum, has lately come prominently into favour. The main danger in the operation is that of wounding the peritoneum. The method which is often adopted to avoid this danger is to introduce into the rectum an india-rubber bag of a pyriform shape (Petersen's bag), to which is attached a piece of india-rubber tubing provided with a stopcock (fig. 374). This bag is introduced empty, and then filled with from ten to twelve ounces of water. This proceeding elongates the prostatic urethra, lifts the bladder out of the pelvis, and pushes the peritoneum out of the way. It is not, however, unattended with risk, and cases have been recorded where the rectum has been torn, so that under no circumstances should more than twelve ounces of fluid be inserted into the bag. Another objection to its use is that it causes pressure on the prostatic sinuses, and produces congestion of the vessels over the bladder, and a good deal of venous hæmorrhage. In my own practice I have therefore entirely discarded the use of the bag, except in those cases where the bladder is so contracted that it will not hold eight or ten ounces of fluid. If it will do this, there has never been any difficulty in my hands in opening the bladder outside the peritoneum. Some surgeons adopt Trendelenburg's position, with the pelvis well raised, so that the intestines by gravitation seek the upper part of the abdomen ; and when the abdominal wall has been cut through, the pressure of the air pushes the peritoneum towards them. I have not found this position necessary, and it is not so convenient for the operator. The bladder is to be washed out at the commencement of the operation, and then from eight to ten ounces of boric acid solution (5 per cent.) is injected and left in. It is better to do this with a silver catheter, which is then retained in the bladder, and may be a useful guide at a later stage of the operation. The fluid is prevented from escaping by plugging the catheter and tying a piece of india-rubber tubing around the penis, sufficiently tightly to compress the urethra against the catheter. The pubes having been shaved and properly cleansed, an incision about three inches long is made in the middle line immediately above the symphysis pubis, the abdominal wall divided, and the cellular tissue between the back of the pubic bones and the bladder opened up. This often contains an abundance of fat, and this is to be torn though with a director, keeping to the middle line. It is better not to use the knife in this stage of the operation, as this tissue contains a number of large veins, which will bleed freely if divided, especially if a rectal bag has been used. The anterior surface of the bladder, when it is reached, will be recognised by its muscular fibres. If there is any difficulty in finding it, by depressing the handle of the catheter in the urethra the point of the instrument can be made to push the coats of the bladder upwards, when they will be easily recognised. When the bladder is reached, a needle on a handle should be passed through its coats on either side of the spot selected for the opening, and two long pieces of silk inserted and fastened temporarily. These should be held by an assistant, and they form a useful guide to the opening, which otherwise may become lost when the fluid is evacuated from the bladder. The bladder is punctured between these two stays, the opening being made large enough to admit the forefinger. The finger is now introduced into the bladder and the stone felt for. If the stone is large and the opening into the bladder is not judged to be sufficient to extract the stone without bruising the edges of the opening, it must be enlarged by a blunt-pointed bistoury introduced by the side of the finger, and by cutting downwards towards the pubes. The stone having been felt is generally easily removed by introducing a scoop by the side of the finger and fixing the stone between the bowl of the scoop and the tip of the finger ; or sometimes it may more conveniently be removed with lithotomy forceps, or by the two forefingers introduced into the wound. The after treatment of the wound must vary according to circumstances. If there is no cystitis, the urine acid, and the walls of the bladder fairly healthy, the better plan is to suture the wound in the bladder, after the manner of Lembert, with buried catgut sutures, and the external wound is then closed with silkworm-gut sutures, except at its lowermost angle, where a drainage tube should be inserted ; but if the urine is ammoniacal or the walls of the bladder thickened, or there has been much difficulty in extracting the stone, so that bruising may have occurred, it is better not to attempt to suture the bladder. A large empyema tube should be inserted into it, the shield of which rests on the abdominal wall; and the surfaces having been dusted with iodoform, the upper part only of the external wound is to be sutured, the lower part around the tube being left open. The best dressing in my hands has been to cover the wound and parts around with three or four layers of gauze, and then place over this a large flat sponge, which is held in position by a single turn of bandage, pinned over it. Two sponges should be provided, and the nurse should be instructed to change them every hour. The sponge not in use, after being washed, is kept in 1 in 40 carbolic acid solution, and is wrung out in hot water just before it is applied. This readily takes up the urine, which escapes by the tube, and the patient may by this means be kept perfectly dry. The tube may be removed on the fourth or fifth day, and the wound will then in all probability speedily close.

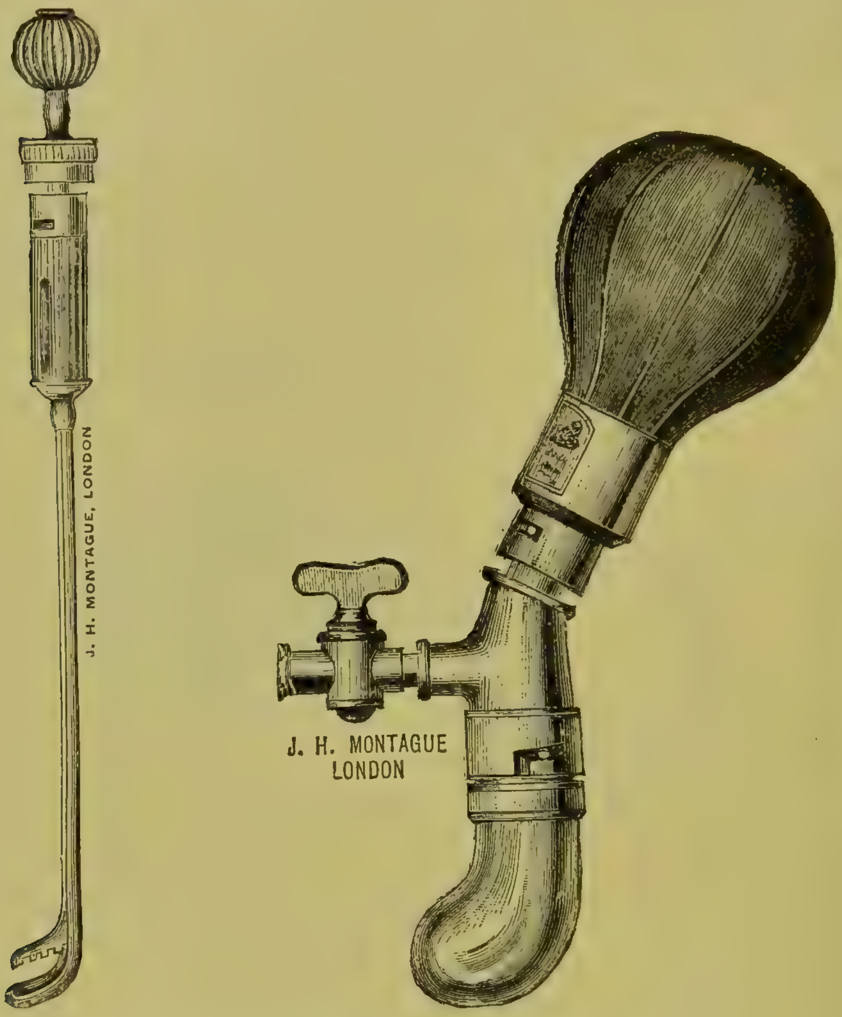

FIG. 375.—Bigelow's lithotrite and Morgan's evacuator, modified by Reginald Harrison for litholapaxy.

2. **Lithotrity.**—The other mode of extracting a stone from the bladder is by the operation known as *lithotrity*, which consists in crushing

the stone in the bladder by a suitable instrument, called a *lithotrite*, and then washing out, by means of an evacuating bottle, the crushed fragments. This operation has recently undergone a very great modification. Until within the last twenty years, the operation consisted in crushing the stone by repeated operations which were made as short as possible, and then allowing the fragments to come away with the urine. In 1878 Bigelow revolutionised the whole operation by completing it at a single sitting, by first thoroughly crushing the stone and then removing the fragments by means of evacuating tubes connected with a suction bottle. To this operation the name of *litholapaxy* has been given. It is performed as follows: For a few days before the operation the patient should be confined to bed, on a light diet, and his bowels carefully regulated. If any cystitis is present and the urine foul, the bladder should be washed out

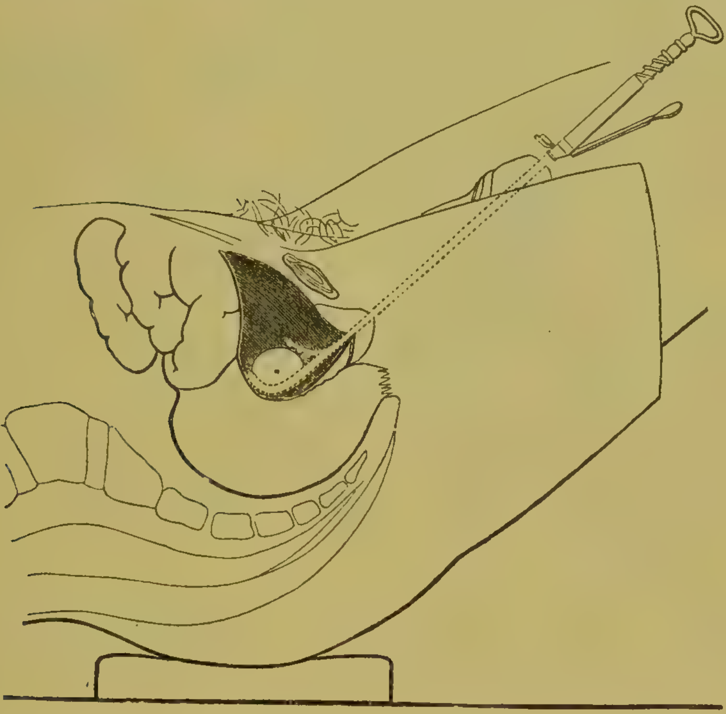

FIG. 376.—Diagram showing one method of seizing the stone in lithotrity. (From Holmes's 'Principles and Practice of Surgery.')

regularly with boric acid solution or boro-glyceride. On the morning of the operation the rectum should be emptied by an enema. The patient must be protected from cold by having the thighs and legs wrapped in pieces of blanket and the upper portion of the trunk well covered up, so that no part of the body, except what is absolutely necessary, is exposed. The patient should be laid on a hard mattress, with a firm pillow under his buttocks, so as to slightly raise the pelvis. After anæsthesia has been induced, about six ounces of boric acid solution should be injected into the bladder, and the lithotrite introduced. The forms of lithotrite vary; but the one usually used in this country is either Thompson's modification of Civiale's instrument, or Bigelow's (fig. 375) with a fully fenestrated female blade. It must be made of the finest tempered steel, otherwise there will be a risk of its breaking. It is passed into the bladder with the blades closed, and the stone felt for. The instrument is placed alongside of the stone, and the blades opened; by depressing the lithotrite against the floor of the bladder, the stone will probably roll between the open blades and can at once be seized (fig. 376). If it does not do so, by slightly shaking the instrument, or jarring it with the other hand, the stone will be felt to fall between the blades, and it is then seized by pushing the male blade down upon it. The lithotrite is then locked and screwed up, and the stone will be felt to give way. Without moving the instrument, the blades are again opened and the manœuvre repeated, and this is continued as long as any fragments can be coaxed to fall between the open blades. All this may sometimes be done without once moving the lithotrite from the position that it was first made to assume, and it must be ever present in the surgeon's mind that the less he moves the instrument about in the bladder, the less damage he will do. The other method of seizing the stone is not nearly so good, because it necessitates the moving about of the lithotrite in the bladder, with consequently more injury to its coats. It has, however, to be resorted to when the stone is lodged in a pouch behind an enlarged prostate and cannot be seized in any other way. This plan consists in turning the lithotrite in the bladder, so that the blades are directed downwards or to one side, and then, after opening them, to attempt to pick up the stone (fig. 377). In this proceeding there is always the risk of including a portion of the mucous membrane of the bladder between the blades of the instrument; and therefore it is necessary, after the stone is seized, to move the lithotrite towards the centre of the bladder before the stone is crushed. After all the fragments which can be found have been crushed, the lithotrite is withdrawn, and the largest size evacuating tube which can be passed is introduced into the bladder. In order to do this, it is generally necessary to incise the orifice of the urethra. The evacuating tubes are made either straight or slightly curved at their

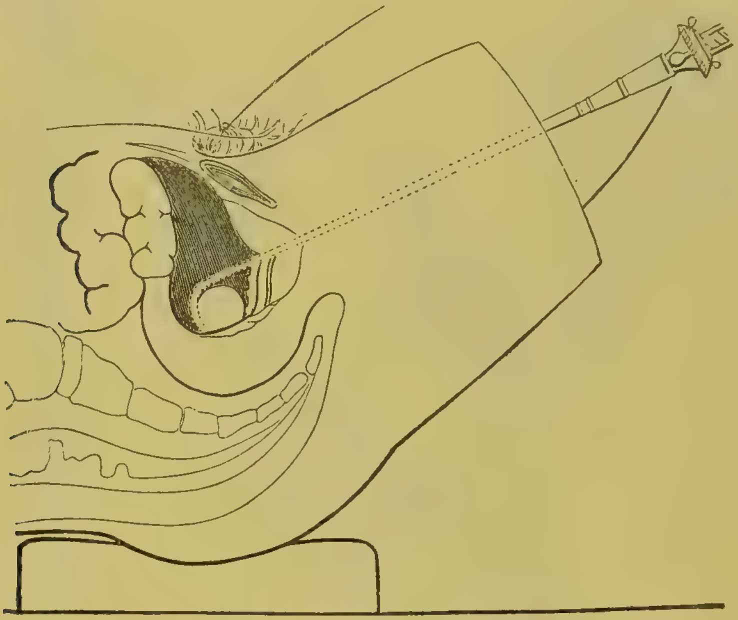

FIG. 377.—Diagram showing a second method of seizing a stone in lithotrity. (From Holmes's 'Principles and Practice of Surgery.')

extremity. The former should be used, if it can be passed, as the fragments find their way out through it more easily; but the curved tubes will be found more easy to introduce. After the tube has been passed, the evacuating bottle (fig. 375) is attached to it, having first been filled with hot boric acid solution. The bottle is then compressed, and the fluid driven into the bladder: upon relaxing the compression, the fluid returns to the bottle, carrying with it the fragments of stone, which sink into the glass receptacle attached to the apparatus. The alternate compression and relaxation are continued until no more fragments appear.

Occasionally it will happen that, though no more fragments appear, every time the water returns to the bottle the impact of a piece of stone against the metal tube is felt. This will indicate that there is a fragment of stone in the bladder which is too large to pass through the evacuator. The lithotrite must then be reintroduced, and the fragment or fragments crushed. When, after washing out, no débris appears in the bottle, and no rattle can be felt against the tube, the operation must be regarded as completed. The patient should be wrapped up in blankets and arranged comfortably in bed, with hot-water bottles about him. Usually a subcutaneous injection of morphia, or a morphia suppository, is desirable. He should have nothing but fluid nourishment for a few days. If there is irritability of the bladder, a mixture containing bicarbonate of potash and tincture of hyoscyamus will be found of use.

In dealing with very large hard stones in adult males, Dolbeau practises lithotrity through a perineal wound. A median perineal cystotomy is first performed and an opening made sufficiently large to admit the index finger. Through this incision a giant lithotrite is passed, the combined blades of which correspond in size to the index finger, and with which a mulberry calculus weighing from four to six ounces can be speedily crushed. The fragments are removed in the ordinary way with the cannula and evacuating syringe. After the stone has been withdrawn, the finger can be introduced in order to ascertain that every fragment has been removed.

Choice of operation.—There can be no question that in the hands of a competent surgeon the operation of litholapaxy is the ideal operation for stone in the bladder, and the rule may be laid down that lithotrity should be performed whenever feasible. Perhaps the only objection that can be raised to such a rule is that there is no doubt that this operation is oftener followed by a recurrence of the stone than lithotomy. In spite of the greatest care and caution on the part of the surgeon, it constantly happens that a small fragment gets lodged in some fold of the mucous membrane of the bladder, and on this another stone is built up: but in these days, with our improved methods of operating, in the hands of surgeons who have become skilled in the necessary manipulations, these recurrences are not nearly so common as they used to be.

In laying down this rule, that litholapaxy is the operation which should be preferred for stone in the bladder, we must bear in mind that there are very many cases in which it is contra-indicated. In considering these contra-indications, we have to determine the condition of the stone and the state of the urinary organs. With regard to the stone, it may be said at once that when it is encysted it is an absolute bar to the operation of lithotrity. As regards its size, considerable difference of opinion exists. In the old days of lithotrity, the rule used to be that no attempt should be made to crush a stone which was more than an inch and a half in diameter, and some surgeons still adhere to the same rule. But it is undoubtedly a fact that much larger stones than this can be crushed by the more modern operation of litholapaxy. Notably in a case recorded by Milton, where he had to employ a lithotrite in which the blades of the instrument had to be separated for five inches. Nevertheless, it must be admitted that the size of the stone has an important influence in determining whether lithotrity or lithotomy shall be performed. Of perhaps more importance than the size of the stone is its composition. An oxalate of lime stone is exceedingly hard and difficult to crush, and many a surgeon would hesitate much more about attempting to crush a stone of considerable size when it consists of oxalate of lime, than he would when it is composed of lithic acid, which is much more easily broken up. Phosphatic stones are soft and friable, and a stone of large size consisting of this material may be attacked with confidence. But it must always be borne in mind that a stone which is apparently phosphatic may merely consist of a coating of this material, with a large nucleus of lithic acid or oxalate of lime; and it may be found necessary, after breaking down the phosphatic casing, to proceed to lithotomy to remove a nucleus consisting of some hard material. The multiplicity of stones is no bar to lithotrity; the only objection is that the amount of stone to come away from the urethra, and the prolonged operation required for their removal, may cause a dangerous amount of irritation, and therefore when the stones are very numerous, lithotomy rather than lithotrity is indicated.

With regard to the condition of the urinary organs, if there are evidences of extensive renal disease, my own feeling would be in favour of lithotomy, as less likely to interfere with the functions of the organs than a prolonged operation like lithotrity, in which cystitis, which may spread to the kidneys, is liable to be set up. But this opinion is not universal. Many surgeons believe that there is less danger from a carefully conducted litholapaxy. A good deal must depend upon the size of the stone and the ability of the surgeon to complete the operation in one sitting. With regard to the bladder, great hypertrophy and sacculation is a decided bar to lithotrity, on account of the difficulty of getting rid of the fragments which become lodged in the pouches and form the nuclei for fresh stones. Again, severe cystitis, with great irritability of the bladder, is a contra-indication to lithotrity, especially if the stone is large; though a moderate degree of cystitis is no reason why this operation should not be performed. When the stone is lodged in a pouch behind an enlarged prostate, lithotomy is probably the better operation, not only on account of the difficulty in seizing the stone, but also on account of the difficulty in evacuating the fragments which sink to the bottom of the pouch, where the evacuating tube cannot be introduced, and where therefore they may remain undisturbed by the eddy of fluid around the end of the tube. With regard to a small contracted bladder, it is better to perform lithotomy, if the organ is incapable of holding less than six ounces. Finally, with regard to the urethra. Strictures of this canal need be no barrier to lithotrity if the stricture can be dilated to admit an evacuating tube equal to about No. 14 or 16 English catheter; but if the stricture is of old standing and cannot be dilated to this size, it is better to perform lithotomy. In cases of irritable urethra, there is no objection to lithotrity if the operation can be performed at one sitting: but if there is any doubt about this, and there is a probability of more than one sitting being required, or of fragments being left in the bladder which may perchance be passed with the urine, lithotomy had better be performed.

A word requires to be said about the choice of an operation in male children. There is no doubt that litholapaxy has much in its favour, inasmuch as it is unattended by those risks which must always follow cutting operations, especially when it is impossible to maintain strict asepticity, and also because there is a speedy convalescence, the child being practically well the next day; but it is an operation which should only be performed by those who are in the habit of performing lithotrity, and who are provided with a complete outfit of the necessary instruments, for unless this is so, terrible disasters, such as rupture of the bladder and tearing across of the urethra, may occur. I am of opinion that while in the hands of the expert it is a most satisfactory and safe operation, it is wiser for the surgeon who has only very rarely to deal with a case of stone in the bladder to perform lithotomy, which after all in children is a very successful operation.

Having thus discussed the conditions under which lithotomy and lithotrity are indicated, it remains now to say a word or two as to the choice between the two operations of lateral and supra-pubic lithotomy. It would seem more than probable that lateral lithotomy will in the no far distant future become an almost obsolete operation, and that the supra-pubic operation will entirely take its place. There would appear to be only two classes of cases where the supra-pubic operation is contra-indicated: (1) where there is a very small and contracted bladder which cannot be distended sufficiently to make it emerge from behind the symphysis pubis; and (2) where there is acute septic inflammation of the bladder, with foul putrid urine which may become infiltrated into the cellular tissue outside the bladder and do irretrievable mischief. The operation is especially indicated in very large, hard stones: where the stones are multiple: where the stone is encysted: where the pelvis is deformed by rickets or osteo-malacia, so as to render extraction through the outlet of the pelvis difficult or impossible. In cases of ankylosis of the left hip, which prevents the patient being placed in the lithotomy position, the supra-pubic operation is indicated; though lateral lithotomy may be performed in these cases on the right side, as I once saw done by the late Sir Prescott Hewett.

Stone in the female is of much less common occurrence than in the male. This is no doubt partly due to the higher living and the greater amount of stimulant which the male is accustomed to; but also, as pointed out above, partly due to the fact that, owing to the shortness and dilatability of the female urethra and the absence of the prostate gland, stones when formed are easily passed, and therefore do not come under the notice of the surgeon.

The **symptoms** are the same as in the male—pain, irritability, the passage of blood, and the occasional arrest of the stream. Incontinence of urine is a not infrequent symptom. As the stone becomes large and heavy it bulges out the posterior wall of the bladder into the vagina, and becomes to a certain extent pouched.

Treatment.—The stone may be removed by lithectasy, lithotomy, and lithotrity. Lithectasy, or removal of the stone through a dilated urethra, should always be resorted to when the stone is not more than an inch in diameter. The patient is placed under an anæsthetic, and the urethra dilated with a Weiss's dilator until it will allow of the introduction of a small pair of lithotomy forceps, with which the stone should be gently extracted. When it is more than an inch in diameter the amount of laceration and undue stretching has to be so great in order to extract, that permanent incontinence is likely to be set up. In stones of larger size, supra-pubic lithotomy is the best mode of extracting the stone, and is to be preferred to lithotrity. For, as Sir H. Thompson says, 'the bladder soon becomes empty, and the manipulation and removal of large, sharp and angular fragments in that condition is, I consider, a very hazardous proceeding, and one which probably involves more damage to the urethra, to say nothing of the bladder, than the removal of a good-sized stone entire.'

The female urethra and bladder do not lend themselves very readily to the rapid removal of the stone by the evacuating bottle. As soon as the water is forced into the bladder from the bottle, it escapes by the urethra and does not return into the bottle.

It is right, however, to state that Keegan, who has had perhaps more experience of stone in the bladder than any other living surgeon, states that the great majority of stones in the female bladder are best removed by litholapaxy ; and that 'any surgeon who at the close of the nineteenth century adopts as a routine practice the old method of rapid dilatation of the female urethra with extraction is behind the age.'

DISEASES OF THE PROSTATE

Acute inflammation of the prostate gland.—Acute prostatitis is very rare as an idiopathic affection, but not uncommonly occurs as the result of gonorrhœa, the septic inflammation spreading backwards to the prostatic urethra and to the prostate gland. It may also be set up by injury, especially from rough catheterism and the formation of a false passage in the prostatic urethra. As rarer causes, may be mentioned stricture, and the retention of decomposing urine ; the presence of calculi in the prostate ; and inflammation extending to the gland in a case of cystitis.

The **symptoms** are deep-seated pain, with a sensation of heat and weight in the perineum ; frequent desire to pass water, with pain during the passage, especially towards the end of the act. Defæcation is very painful ; and upon examination per rectum the prostate is felt to be enlarged, hot, and exquisitely painful. The perineum is also hot and tender. The sitting position is particularly painful, and if the patient is requested to sit down he will be noticed to support the weight of his body on one buttock to avoid pressing on the perineum. The inflammation usually runs on to suppuration, and when it does, the pain becomes more intense and throbbing in character, the tissues in the perineum become red and œdematous, and there is fever, with probably a rigor. Under these circumstances, retention may occur, and the passage of a catheter is attended by intense pain.

The abscess which forms usually bursts into the urethra, and pus is discharged per urethram ; but in these cases there is often a discharge of pus from the urethra before the abscess bursts, from inflammation of the prostatic urethra. If the exit for the pus from the abscess is free, a speedy relief quickly follows the bursting of the abscess, and the case usually does well ; but in many cases only a small opening forms, and the abscess cavity does not completely empty itself, and under these circumstances the matter is likely to burrow and burst into the rectum, or externally in the perineum, and this may give rise to fistula.

Treatment.—The patient should be confined to bed and put upon a bland diet. In the early stages leeches should be applied to the perineum, and be followed by hot fomentations. A hot hip bath will often give great relief. The bowels should be kept loose, to prevent any hardened masses of fæces in the rectum pressing on the inflamed gland. If the pain is extreme it is best subdued by morphia suppositories, to which extract of belladonna may be added with advantage. If retention occurs, the bladder should be emptied by passing a medium size red-rubber catheter, or if there is any difficulty in introducing this, a black coudé catheter should be used. Occasionally the passage of the instrument may rupture the abscess and lead to the evacuation of the pus. If, however, it does not do so, and there is evidence that suppuration has set in, the patient should be placed in the lithotomy position, and an incision made in the median line of the perineum and carried deeply until the pus is reached. A drainage tube must then be inserted.

Chronic inflammation of the prostate gland, or **chronic prostatitis.**—Chronic inflammation of the prostate is usually the sequel of the acute, especially when the acute disease has been set up by gonorrhœa, and a gleet persists after the acute symptoms have subsided. It may also result from excessive sexual intercourse or masturbation, and sometimes is a complication of stricture of the urethra. The organ is enlarged and indurated from inflammatory exudation, and this may gradually break down and form a chronic abscess in the substance of the gland.

Symptoms.—The patient complains of pain and weight in the perineum, which is increased by exercise, especially riding on horseback, and by sexual intercourse. There is some irritability of the bladder, and pain in the extremity of the penis towards the end of the act of micturition. The urine contains a variable amount of glairy discharge, which is expelled with the urine last voided from the bladder, and upon examination fine threads of mucus—casts of the prostatic ducts—may be seen floating in it. To this the name of *prostatorrhœa* is given, and the condition is often mistaken by the patient for spermatorrhœa. There is usually constipation, and the passage of a solid motion is attended by pain and the discharge of mucus and threads, which is mistaken for semen. Upon examination per rectum the prostate is felt to be enlarged and tender to the touch.

Treatment.—The treatment consists, in the first instance, in improving the patient's general health. Tonics, especially strychnia and iron; a carefully regulated diet; change of air, and more particularly sea-air and sea-bathing, are indicated. The bowels must be kept freely open by laxatives. As regards local treatment, blisters to the perineum are recommended, and sometimes do good. If they fail, the injection of a solution of nitrate of silver (10 or 15 grs. to ℥j) to the prostatic urethra is often followed by the best results. This is applied by means of a catheter which is perforated at its extremity by a number of small openings and carries a piston, to the end of which an elongated piece of sponge is attached which is saturated with the solution. When the piston is pressed home it squeezes the solution out of the sponge through the openings in the catheter, which is introduced into the prostatic urethra. A cold sitz bath (temperature 35°F.) every night is recommended by some in these cases. If a chronic abscess should form, it will be detected by examination per rectum, and must be opened by an incision in the middle line of the perineum.

Senile enlargement of the prostate.—This is a disease which occurs in advanced life, seldom appearing before the age of fifty or fifty-five. Sir H. Thompson states that it is present in one-third of all males over the age of sixty, but only produces symptoms in one case out of every fifteen. It used to be considered that the enlargement was a merely physiological process, due to advancing years, but this is now not believed to be the case. Some men attain a considerable age without any enlargement at all. By many it is believed that the enlargement occurs most frequently in those whose sexual vigour has been considerable in early life, and by others that it is due to previous attacks of gonorrhœa, especially when these attacks have been complicated by prostatic congestion or inflammation. The enlargement is due to an increase in all the tissues of which the gland is composed—muscular, connective, and glandular—but these tissues are not increased so as to preserve their relative proportions to each other; and though in most cases the whole of the gland is enlarged, in others only one lobe—it may be the middle lobe or one of the lateral lobes—is increased in size (figs. 378 and 379). In most cases it is the connective tissue of the gland which is principally increased, and these are the cases where the organ attains its largest size. In some instances a local hypertrophy of the muscular or glandular element may take place, and an isolated tumour be formed which is first embedded in the gland and may after a time protrude from the gland into the urethra or bladder, forming a pedunculated tumour. When the muscular element is principally involved, a tumour is formed which exactly resembles a 'fibroid' tumour of the uterus, and when embedded in the gland can be readily

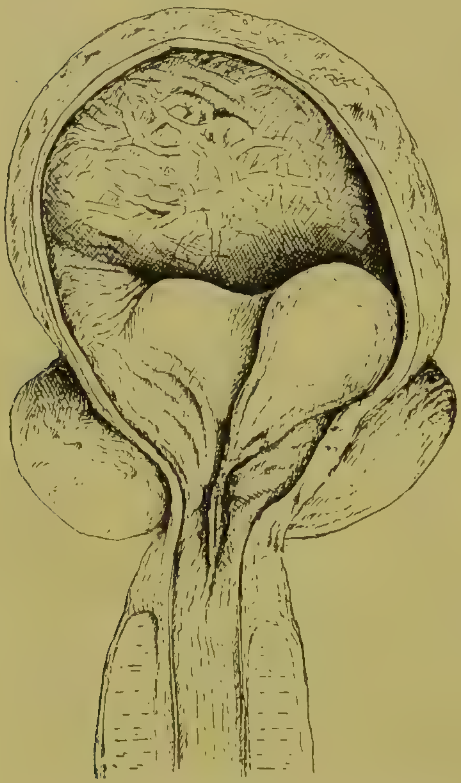

Fig. 378.—Enlargement of the lateral lobes of the prostate. (From the Museum of St. George's Hospital.)

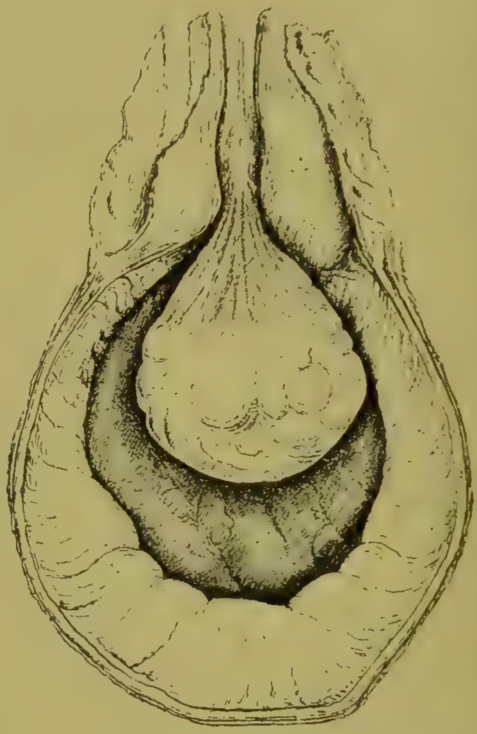

Fig. 379.—Enlargement of the middle lobe of the prostate. (From the Museum of St. George's Hospital.)

enucleated. When the glandular tissue is the part hypertrophied a circumscribed tumour analogous to the fibro-adenoma of the breast is formed. These tumours may be single or multiple, and are frequently associated with some general enlargement of the prostate.

In consequence of the increase in size of the prostate, changes take place in the shape of the prostatic urethra : it is elongated, and when the enlargement principally implicates the lateral lobes it is compressed laterally and forms a narrow chink ; when the middle lobe is affected, a rounded bar may extend across the orifice of the urethra, which forms an important barrier to the patient emptying his bladder. When one lateral lobe is affected, or a circumscribed tumour forms in one of them, the urethra is deflected to the opposite side. Under any of these circumstances obstruction is the result, but in some rare instances incontinence is present from a widening out of the urethral orifice, from a growing backwards of the middle lobe into the bladder, so that the urethra is stretched, and the urine escapes by the sides of the middle lobe.

The results of enlargement of the prostate upon the other urinary organs are as follows : the bladder may be contracted with hypertrophy ; dilated with hypertrophy ; or dilated without hypertrophy (see page 952). The most common change is hypertrophy with dilatation and sacculation, and the dilatation especially effects the posterior wall of the bladder, which becomes expanded into a sac-like pouch, forming a reservoir behind the prostate, in which the urine collects, and from which it cannot be expelled. The ureters become dilated; the pelvis and calyces of the kidneys enlarged, and the secreting structure absorbed, and a condition of chronic interstitial nephritis set up.

Symptoms.—The symptoms in the early stage come on insidiously ; there is perhaps first of all a certain amount of hesitation at the commencement of the act of micturition, and the patient finds that he has to strain for a few seconds before the urine flows. When it does flow, it will be noticed that it does not come in a forcible, but an inert stream, which, though it may be of a fair size, seems to flow away, and the last few drops pass without control. There may be at first no increased frequency, but after a time the patient notices that the calls to make water are more frequent than they used to be ; and this is especially noticeable at night, when he finds that he has to rise once or twice or oftener to empty his bladder. As the case progresses, the pouch behind the prostate forms, and the bladder is not completely emptied. There is now a feeling of weight and discomfort in the perineum, and the patient does not get complete relief from passing water. The urine which is retained in the pouch decomposes, and the water becomes altered in character. At first it is neutral, and a cloud of mucus will be seen floating in it ; then it becomes fœtid, ammoniacal, and contains pus or muco-pus. Cystitis is now set up ; the irritability of the bladder is greatly increased ; and pain is experienced on making pressure in the hypogastric region. From the straining, prolapse of the rectum or an inguinal hernia may be caused, or piles may make their appearance. In some cases the obstruction may be so great that the bladder may become distended, and then the urine may dribble away. In other cases sudden retention may come on, even before the enlargement of the prostate has been suspected. This is usually due to a sudden attack of congestion of the enlarged organ, from exposure to cold or from over-indulgence in alcohol. After the urine has become decomposed and cystitis is set up, the patient's health begins to fail, from the night's rest becoming broken, and from septic absorption; the kidneys become involved, and uræmic symptoms set in, and a fatal termination ensues.

The **diagnosis** of enlarged prostate is not difficult. When an elderly man comes complaining of some difficulty in commencing the act of micturition; of having to get up two or three times during the night to pass water, and in whom the stream is propelled with little force, the inference is that the prostate is enlarged, and this is at once confirmed by an examination of the rectum, when the increase in the size of the organ can be felt. The next point to ascertain is whether he is capable of completely emptying his bladder; and this is to be done by requesting him to pass water, and immediately afterwards passing a soft catheter; the amount of urine he is unable to pass will be drawn off by the catheter.

Treatment.—The treatment of enlarged prostate must depend upon whether the patient is able to empty his bladder or not. If he can, there is no necessity for him to resort to the habitual use of the catheter, and the treatment must consist in strict attention to diet, in avoidance of all alcoholic excesses or sexual excitement, and in keeping the digestive functions in regular order. In the great majority of cases, however, when a patient applies for advice with enlarged prostate, it will be found that he is unable to completely empty his bladder; possibly an ounce or a couple of ounces of urine will be found to be retained. Under these circumstances, he should be advised at once to enter upon the so-called 'catheter life.' This consists in passing an instrument once a day, to draw off the residual urine and prevent its decomposition. The great thing to fear in these cases is that the water which is retained in the bladder should decompose and set up cystitis, and this can only be prevented by regularly emptying the bladder mechanically. The best time to select for the operation is bedtime. The patient then gets some hours' sleep before the bladder accumulates sufficient water to compel him to rise to void it.

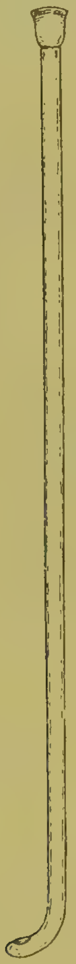

FIG. 380.
A coudé catheter.

The patient should be taught to pass an instrument for himself, and this is not always an easy thing to do. The best form of instrument for the patient's own personal use is the Jaques red-rubber catheter, because with this he can do no harm, and, moreover, it is often the form of instrument which will most easily find its way along a deflected urethra. But occasionally this instrument cannot be passed, and then a coudé catheter may be tried. This form of instrument is made with about an inch at the end bent upwards at an obtuse angle, and is especially useful in cases where the middle lobe of the prostate is enlarged, or where there is a bar across the neck of the bladder (fig. 380). In other cases the silk-web catheter may be found the most easy of introduction. In no instance should a silver or metal catheter be entrusted to the patient for introduction on his own person. The patient should be strictly enjoined to preserve the instrument absolutely clean, and instructions should be given as to its efficient sterilisation before and after use. He should also be told to examine it occasionally for any flaw or crack, and if such is present to abandon it for a new one.

Catheter fever.—Great care of the patient must be observed upon his entrance into catheter life. It is not uncommon for a patient to develop, during the first week or ten days after the commencement of the habitual use of the catheter, a condition of fever, with a diminution of the specific gravity of the urine. The urine becomes cloudy, though it may still retain its acid reaction; a small quantity of albumen makes its appearance; and when examined microscopically, it is found to contain myriads of bacteria. There is seldom any definite rigor, but a sensation of chilliness, followed by heat; the pulse is rapid; the tongue dry and red; there is loss of appetite; sometimes delirium; and the patient becomes semi-comatose, and usually dies. This condition has been attributed (1) to repeated shocks to the nervous system, from the passage of instruments; (2) to the suddenness with which the change is made from the natural and usual mode of micturition to the artificial one; and to removing the whole of the residual urine (to which for a long time the bladder has been habituated) at once and upon each introduction of the catheter; and (3) to infection of micro-organisms from without. The latter of these three causes is in all probability the true one. The source of these organisms is the urethra, where they exist in profusion; and unless the most stringent measures are taken to prevent it, some of these organisms will be introduced into the bladder by means of the catheter. If the bladder is not capable of emptying itself, these organisms increase and multiply in the residual urine, which forms an excellent nutrient medium for their growth, and septic cystitis is set up; whereas if the bladder is healthy and capable of emptying itself, no harm results. Every care must be taken to prevent this. Before catheterism, the glans penis and meatus should be washed with boric acid solution, and the urethra syringed out with the same. The catheters must be kept absolutely clean.

Catheter fever must not be confounded with another condition, which is termed urethral fever, where a sudden rise of temperature, with a rigor followed by sweating, occurs within a few hours after the introduction of a catheter or some other operation on the urinary organs. The origin of this condition is still obscure. It is believed by some to be due to the absorption of micro-organisms, or their products, from the urethra; but would appear more probably to be due to some interference with the circulation in the kidney, from the reflex irritation produced by the passage of an instrument.

Retention from enlarged prostate.—In those cases of enlarged prostate where retention suddenly comes on, the patient must be relieved, if possible, by the passage of a catheter. And this can generally be done if the surgeon perseveres with different forms of instruments. In the first instance, he should resort to a Jaques catheter; and it is astonishing in how many cases this form of instrument can be passed where many other varieties have been tried and failed. It adapts itself so easily to the windings or deflections of the canal that it will often pass when a stiffer instrument will not. Too large a sized catheter should not be used, as it is desirable to draw off the water slowly, so as to allow the bladder to recover its tone and contract on the urine as it is withdrawn. No. 6 or 7 English size is best. In those cases where there has been a gradual accumulation in the bladder, the whole of the water should not be removed at the first sitting; some should be left behind to be subsequently removed. Should the surgeon fail to pass the Jaques catheter, a coudé or bicoudé may be tried, or the plan advocated by Sir Benjamin Brodie may be resorted to. This consists in passing a gum-elastic catheter with a stilette down to the prostatic urethra: when the point of the instrument impinges against the enlarged middle lobe of the prostate gland the stilette is withdrawn about an inch; this causes the point of the catheter to curl upwards, and it will then ride over the enlarged lobe into the bladder. Finally, the prostatic silver catheter may be tried. This is a catheter with a very much larger curve than the ordinary one, and can sometimes be introduced when all other instruments fail. The greatest gentleness and care must, however, be exercised, and the old-fashioned barbarous plan of 'tunnelling' the prostate, as it was called—pushing the instrument through the prostate—never resorted to. In those very rare cases where the surgeon is not successful in passing any instrument, he must proceed to aspirate the bladder above the pubes; this may require doing two or three times, and then, the pressure being removed from the bladder, the congestion of the prostate will subside, and he will succeed in getting an instrument into the bladder. During catheter life the patient must be counselled to preserve a strictly moderate life, especially as regards eating and drinking; he must avoid all sexual excitement and exposure to chills, damp, and fatigue. Under these circumstances, he may enjoy several years of comparative comfort. But at the same time the treatment by the habitual use of the catheter is not always satisfactory. It is likely to set up cystitis, and it destroys the tone of the bladder, and is said by some to help in establishing grave degenerative changes in the kidney.

Surgeons have of late years been very active in devising other plans of treating enlarged prostate, and various operative proceedings have been proposed from time to time for the relief of this condition.

1. **Prostatotomy,** or division of the prostate, is especially useful in those cases where a bar exists across the neck of the bladder, or where cystitis is present, necessitating continuous drainage. The operation consists in performing an ordinary perineal cystotomy. The membranous urethra is cut down upon in the middle line of the perineum, and the finger introduced into the bladder. The projecting bar is divided with a blunt-pointed bistoury, or broken down with the finger; if any projecting masses of prostatic substance are felt, they are to be removed. A gum-elastic lithotomy tube is then inserted, and the bladder drained. The tube will be required to be retained for many weeks, until the patient can pass his water by the natural passage freely. In some cases a permanent fistulous opening is established in the perineum, through which the patient empties his bladder.

2. Bottini aims at forming a new channel by boring through the prostate gland, by means of the galvano-cautery passed down the urethra: and Watson aims at the same thing, but introduces the cautery through an opening made in the perineum. These operations are, however, not devoid of risk, and the success which has attended them has not been so great as to induce surgeons at large to adopt them.

3. **Prostatectomy.**—This operation consists in opening the bladder above the pubes, and removing the obstructing portions of the gland as freely as possible. The patient is placed in Trendelenburg's position. After the bladder has been thoroughly washed out with boracic solution, about ten ounces of the solution are injected into it: and the

pelvis is then raised considerably, so that the intestines gravitate to the upper part of the abdominal cavity, and the peritoneum being carried with them, is not in danger of being wounded. The bladder having been exposed through a median incision, is opened, and the edges of the wound well retracted. It can then be illuminated by a small electric lamp, and the mucous membrane over the projecting part of the prostate divided; and, partly by means of the fingers and partly by scissors, the whole mass is enucleated. The hæmorrhage is often very free, but can usually be controlled with hot water. The most suitable case for this operation is where a pedunculated or encapsuled tumour exists; but even in those cases where the whole organ is enlarged, those portions which cause the obstruction can be removed, to the great relief of the patient.

4. White of Pennsylvania, and Ramm of Christiania, have recommended **castration** in enlarged prostate, on the principle that removal of the ovaries causes diminution in size of fibroid tumours of the uterus; and that a similar diminution might be expected to take place in the prostate if the testicles were removed. Griffiths says that after castration the gland undergoes degenerative changes, which lead to its conversion into a small tough and fibrous mass, in which there are only remains of the glandular tubules and ducts. William White affirms that rapid atrophy of the prostatic enlargement followed the operation in 87·2 per cent. of the cases, and that the deaths were 20 in 111; that is to say, a percentage of 18. Unilateral castration was in some instances followed by unilateral atrophy. The operation has been frequently performed, and many surgeons speak well of it. There is no doubt that it has been followed in some by an actual diminution in size of the gland in a very few days; but the operation is one of considerable risk in an old man, and in many cases in which the operation has been performed the results have not been satisfactory. More experience is required before a definite opinion in its favour can be given.

5. Reginald Harrison, recognising the danger of double castration, has recommended **vasectomy**, or excision of a portion of the vas deferens of either side, in place of castration. The operation in his hands has yielded some good results, and, as it is a much simpler and less dangerous operation than castration, it should in my opinion be preferred to it.

To sum up the treatment of enlarged prostate. So long as the patient can pass a catheter, and does not suffer from constant cystitis with great irritability of the bladder, or from frequent hæmorrhage, the catheter life should be persevered in. But when these evils supervene, then operative interference should be undertaken. When the obstruction arises from a bar across the neck of the bladder, and there is a considerable amount of cystitis present, a prostatotomy should be performed, and the bladder drained for a time, or a permanent fistulous opening in the perineum formed. When it can be ascertained with the cystoscope that there is a localised projecting outgrowth into the bladder, prostatectomy should be resorted to, and the operations of vasectomy, and certainly castration, reserved for those hopeless cases for which no other plan of treatment seems applicable. White himself does not advocate castration in every case of enlarged prostate. He says that as long as the patient is not very old, retains his sexual power, has sound kidneys and only a moderate amount of residual urine, the operation should not be resorted to; but if the age is great, and the sexual powers greatly diminished or extinct, and at the same time the renal and general condition is good, castration holds out the 'most benefit with the least mortality.' In the worst cases, in which 'the prostate is enormous, the cystitis excessive, the bladder dilated and atonied, the retention absolute, and catheterism difficult and occasionally impossible,' castration is the best procedure, though attended with risk.

Tuberculous disease of the prostate.—Tuberculous disease of the prostate may begin as a primary disease in the gland, but more commonly is part of a general tuberculosis of the genito-urinary organs, which begins in the testicle and spreads by the vas deferens to the vesicula seminalis and thence to the prostate and bladder; or else begins in the kidney and spreads down the ureter to the bladder and prostate. The disease may also begin primarily in the bladder and spread to the prostate. When the disease begins in the prostate gland, it is generally the result of a long-standing gleet in a person predisposed to tuberculosis. It usually occurs in early adult life.

The **pathology** of the disease is the same as that of tuberculosis elsewhere. The tubercle bacillus effects an entrance, and slow inflammatory changes take place, which cause an irregular enlargement of the gland. The effused material caseates, and the softened cheesy mass usually discharges into the prostatic urethra, leaving an irregular cavity which shows no tendency to heal. Later, it may open into the rectum or in the perineum, and urinary fistulæ may form.

Symptoms.—In the early stages of the disease the symptoms are very slight: there may be a sense of weight and uneasiness in the perineum, and pain during defæcation; but the patient usually presents himself for some manifestation of tubercle elsewhere, it may be in the testicle, and the condition of the prostate is discovered in the exploration of the case. The prostate will be felt, upon examination per rectum, to be irregularly enlarged, and perhaps in one part a softened spot may be detected. The vesiculæ seminales will also be felt to be enlarged. Later on, when the softened patch has burst into the urethra, there will be frequent desire to pass water, pain at the neck of the bladder, and often in the loins and at the end of the penis. The urine will contain pus or muco-pus, and upon examination the tubercle bacillus may be detected. Blood, towards the end of the act of micturition, is also frequently passed with the urine.

The **treatment** consists in the general treatment of tuberculosis: attention to diet, plenty of fresh air and sunshine, warm clothing, and an equable temperature. Internally, tonics and especially cod-liver oil should be administered, and iodoform in grain doses three times a day may often be given with advantage, when it does not interfere with the patient's digestion. Operative interference is required in those cases where a tuberculous ulcer is present in the prostatic urethra, causing great pain and strangury; a perineal cystotomy should be performed, and the ulcer scraped with a sharp spoon, and iodoform emulsion injected. Where the tuberculous ulcer points externally in the perineum, it should be opened and scraped, and dressed from the bottom with iodoform and gauze. Fistulous tracts require laying open and scraping.

Malignant disease of the prostate.—Either as a primary or secondary affection, cancer of the prostate is rare. It usually occurs in elderly men, and is for the most part of the scirrhus form.

The symptoms are those of pain about the neck of the bladder and frequent desire to pass water. These are followed by obstruction to the flow of urine, and, it may be, complete retention, and after a time hæmaturia, the blood being passed unmixed with urine and at the end of micturition. It is sometimes very severe. Upon examination per rectum the prostate is found to be enlarged, hard, and nodular, and secondary deposits may be felt in the lumbar glands upon abdominal palpation. The inguinal glands are also sometimes enlarged. The disease runs a far more rapid course than senile enlargement, and is attended with emaciation.

The **treatment** is palliative only. For the relief of retention, a soft catheter must be used with great gentleness, or drainage of the bladder may be required. Morphia suppositories appear to be the best means of relieving pain.

Prostatic calculus.—Calculi occasionally form in the prostatic ducts, and may sometimes be multiple. They consist of phosphate of lime and organic matter. They are hard, of a fawn or light brown colour, smooth, and when multiple facetted.

Symptoms.—The symptoms to which they give rise very much resemble those of enlarged prostate, except that the water usually contains blood. Upon passing a metal instrument, it can sometimes be felt grating against the stone as it passes along the prostatic urethra, and this grating sensation can sometimes be more easily produced by introducing the finger into the rectum and pushing the prostate up. Sometimes in examination per rectum the stones, when multiple, can be felt to grate against each other. Occasionally a calculus from the prostate is passed per urethram, and sometimes they give rise to abscess, which is opened or bursts externally, and the stones may be discharged.

Treatment.—If the calculi cause pain or inconvenience, a median perineal section should be made, and the calculi extracted through the wound.

DISEASES OF THE URETHRA

Malformations: Epispadias.—This congenital malformation consists in a deficiency of the upper wall of the urethra; or, as is believed by some, a deficiency of the lower wall of the urethra with torsion of the penis. At all events, in these cases there is a groove on the dorsum of the organ which represents the urethra. This groove may extend the whole length of the penis, when the urethra is entirely absent, and the penis is usually stunted and dwarfed. This condition is frequently associated with extroversion of the bladder (page 950), but some few cases have been recorded where this has not been so. In these the cleft only implicates the glans, and perhaps the anterior portion of the body of the penis, and the urethra terminates by a slit-like orifice on the dorsum of the organ. Where there is a complete epispadias, but without extroversion, there is an infundibuliform opening into the bladder above the pubes. The penis is usually dwarfed and turned upwards, so that the glans lies over the opening. For the relief of this condition Cantwell has introduced a most ingenious operation. This consists in dissecting up a flap, on either side of the open urethra, from the extremity of the glans penis as far backwards as possible into the infundibulum. These flaps are moulded into a tube upon a catheter by bringing their lateral edges together with fine sutures. The corpora cavernosa are now separated from each other with a blunt instrument, and the newly formed tube passed between them and fixed in the proper position for the urethra beneath them. The infundibuliform opening is then closed by prolonging the incisions from the urethral flap around the opening and suturing the cut surfaces together over the newly made urethra. During the proceeding the bladder is kept drained by a perineal opening. In those cases of epispadias where the anterior part of the body of the penis only is involved, the condition may be remedied by a plastic operation similar to that which is performed for hypospadias, to be immediately described.

Hypospadias.—This is a far more common malformation than the preceding, and consists in a cleft condition of the floor of the urethra, owing to an arrest of union in the middle line. The failure in arrest may be partial or complete, and the condition may be considered under three different varieties.

1. *Hypospadias of the glans penis.* — In these cases the glans penis is cleft on its under surface, and the urethra terminates at the point into which the extremity of the frænum is usually inserted into the body of the penis. The mucous membrane of the urethra is here continuous with the skin, and the opening is often very small and valve-like. There is a depression on the glans in the position of the normal meatus. The prepuce is also cleft on its under surface, and forms a sort of hood over the glans. This condition is very common. It produces no disability and requires no treatment. The hooded prepuce, if it is judged necessary, may be removed.

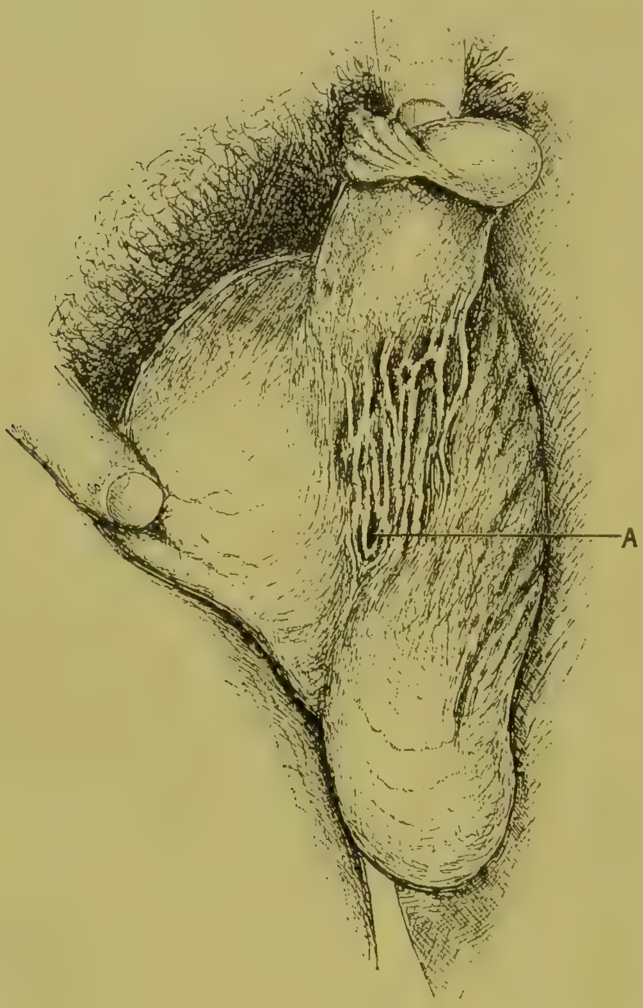

FIG. 381.—Hypospadias. A, orifice of urethra.

2. *Hypospadias penis.*—In these cases the penile portion of the urethra is cleft throughout its entire length, and the opening of the urethra is at the point of junction of the penis and scrotum (fig. 381). The under surface of the penis in the middle line presents a furrow lined by a moist mucous membrane, on either side of which is often more or less dense fibrous tissue, stretching from the glans to the opening of the urethra, which prevents complete erection taking place; the organ at such

times assuming the form of a bow, with the convexity upwards. The prepuce in these cases has the same hood-like form as in hypospadias of the glans. Gradations may sometimes occur between these two forms, the urethra opening at different situations on the under surface of the urethra. Great discomfort is induced during micturition from this malformation, the patient being unable to project the stream away from his body. Connection is also impossible, and the patient impotent. It may be remedied by a series of operations, but these should not be attempted until the patient has reached the age of puberty, as the parts are previously too small for the necessary proceedings. The penis must first be freed by division of the fibrous bands on the under surface. The main part of the urethra is then formed by two flaps taken from the skin on either side of the median furrow. On the one side, say the right, a longitudinal incision is made from the glans penis to the scrotum, on the under surface of the penis, about three-quarters of an inch from the median furrow; at either end of this a transverse incision is made inwards nearly to the median furrow, and the flap thus formed dissected up until it reaches the furrow. On the left side a similar longitudinal incision is made, but close to the furrow, and transverse incisions outwards from either extremity. This flap is now dissected outwards to the extent of about three-quarters of an inch. The right flap is now folded over and the left flap pulled inwards over it, so that the two rawed surfaces of the flaps are in apposition, and one skin surface, that of the right flap, forms the floor of the urethra. The flaps are fixed in this position by a number of fine horsehair sutures. When union takes place, the greater part of the urethra will have been formed. A transverse incision is then made on the dorsum of the hooded prepuce, close to its junction with the glans, sufficiently large to allow of the glans penis being passed through. The prepuce is brought down beneath the glans, and the posterior border—which was originally the free border—of the prepuce is rawed and sutured to the anterior extremity of the new urethra, i.e. the bridge of skin which has been formed by the two flaps. The final operation consists in rawing the skin of the scrotum around the orifice of the urethra and the posterior margin of the bridge of skin, and suturing the two together, so as to complete the urethra behind.

3. *Perineal hypospadias.* — In these cases the urethra is deficient as far back as the perineum, and the scrotum is cleft. The penis is small and bound down between the two halves of the scrotum, so as to resemble an hypertrophied clitoris. The testicles are often retained. The condition of parts, therefore, very much resembles the external organs of generation of the female, and male children the victims of this complete form of hypospadias have been brought up as girls. The halves of the scrotum deficient of testicles resemble the labia, the cleft between them looks like the orifice of the vagina, and the diminutive penis is taken for an enlarged clitoris. There is no remedy for this condition.

Urethritis is generally due to gonorrhœa, but may arise from many other causes: (*a*) from contagion of leucorrhœa; (*b*) from injury; (*c*) from gout; (*d*) from tuberculosis; and, though less frequently, from (*e*) excessive beer drinking; (*f*) irritation of worms; (*g*) the ingestion of turpentine, cantharides, and asparagus; and (*h*) sometimes in secondary syphilis.

Gonorrhœa is an infective inflammation due to the action of a specific micro-organism, the *gonococcus*, which attacks the urethra of the male and the vagina and cervix uteri of the female, sometimes travelling up to the Fallopian tubes and causing salpingitis.

The gonococci appear in pairs—diplococci—the adjacent borders being sometimes concave. They are found with or without other pyogenic organisms in the discharge, but may be distinguished from them and from another variety of diplococcus, which is present in the healthy urethra, by the fact that they are not stained by Gram's method, and are found in the pus and epithelial cells of the discharge as well as outside them. They may be readily demonstrated by placing a drop of the discharge on a cover glass and drying, and then staining with gentian violet or methylene blue. When applied to a mucous surface, they speedily invade the epithelial cells, and after a period of incubation set up an acute infective inflammation, which has a tendency to spread and quickly runs on to suppuration.

Symptoms.—After a period of incubation, which is usually three or four days, but may be as long as a fortnight, a sensation of itching or burning is experienced at the end of the urethra and the lips of the meatus, which will be noticed to be tumid and to have a tendency to stick together. This is quickly followed by a scalding pain during micturition, and the appearance of a thick yellow discharge from the urethra. The lips of the urethra now become puffy and red, and the glans penis and the prepuce swollen. The inflammation travels backwards, and the urethra along the under surface of the penis becomes painful and feels like a hard cord, and, when the inflammation reaches the bulbous portion of the urethra, pain and tension in the perineum are complained of. Sometimes the discharge may be stained with blood, and in somewhat rare cases the swelling of the mucous membrane of the urethra may be so great as to prevent the passage of urine, and retention may result. The inflammation in the urethra may extend to the surrounding corpus spongiosum, and this body becomes infiltrated with plastic exudation. Should erection occur under these circumstances the penis is bent downwards and a painful condition is set up, which is known by the name of *chordee*. During this stage there is a considerable amount of constitutional disturbance, a rise in the temperature, loss of appetite, constipation, and a general feeling of malaise.

In favourable cases, at the end of ten days to a fortnight a subsidence of the acute symptoms takes place, the discharge becomes thinner, the scalding on micturition becomes less, and the swelling disappears. This is the sub-acute stage, and under appropriate treatment this may gradually subside and a cure be effected in a fortnight or three weeks; but if neglected or improperly treated it may degenerate into a gleet, which may persist indefinitely.

By the term **gleet** is understood any mucous or muco-purulent discharge from the urethra, which persists and is not attended by any other definite symptoms. It is usually the result of a chronically inflamed patch of mucous membrane, which becomes dark, red, and granular in appearance; but it may arise from chronic prostatitis, set up by the gonorrhœa. Under these latter circumstances the condition may be diagnosed by the presence in the urine of fine thread-like casts of the ducts of the prostate. In those cases where there is a granular patch in the urethra it will be found that there is a localised tenderness on passing a bougie, but the condition can only be accurately diagnosed by the endoscope. The patches are usually situated in the bulbous portion of the urethra, and are a frequent cause of stricture. A plastic exudation takes place in the sub-epithelial tissues, and this undergoes organisation into fibrous tissue, which subsequently contracts, like scar tissue elsewhere, and leads to a narrowing of the lumen of the tube.

Treatment.—The treatment during the acute stage should consist in keeping the patient as far as possible at rest, on a light unstimulating diet. He should take plenty of barley water, soda and milk, &c., to dilute the urine; the bowels should be kept freely open by saline purges, and the strictest cleanliness observed. If the pain during micturition is very severe and there is irritability of the bladder, it may be relieved by hot sitz baths. If chordee is troublesome, fifteen grains of the bromides of ammonium and potassium may be given at bedtime, and if retention sets in and is not relieved by a hot bath, a soft red-rubber catheter must be passed. This will probably cause some hæmorrhage, which will relieve the congestion of the mucous membrane. As soon as the discharge becomes thinner and less copious, and the scalding disappears, specific treatment may be commenced. This may be of two kinds, either local or constitutional, and considerable difference of opinion exists as to the respective merits of these two methods. In the majority of cases it will be found that a judicious combination of the two is advisable, but the local treatment is the one on which most reliance must be placed. The constitutional treatment consists in the administration of certain drugs, which passing through the blood are excreted by the kidneys, and have a decided effect upon the mucous membrane of the urethra. They are three in number: oil of sandal wood, balsam of copaiba, and cubebs. Of these the oil of sandal wood possesses these advantages, that it is less liable to upset the digestion, and is not apt to produce an erythematous eruption, as copaiba and cubebs do. It is best given in the form of a mixture, in a dose of ten to fifteen minims with a few drops of liquor potassæ. The balsam of copaiba is usually administered in the form of capsules, as it is less likely to cause eructation, and the nauseous taste of the drug is thereby disguised. Each capsule contains ten minims of the balsam, and six to eight of these should be given daily. Cubebs was originally recommended by Sir Astley Cooper for cases of men who had had frequent attacks of gonorrhœa. It is more irritating than copaiba. It is given in half to one drachm doses in cachets.

The local treatment of gonorrhœa consists in the use of antiseptic and astringent injections. Very many different drugs have been used at different times in the form of injections in gonorrhœa. Of those which have proved most useful in the author's hands are a solution of perchloride of mercury (1 in 5,000); permanganate of zinc ($\frac{1}{4}$ gr. to an ounce); sulphocarbolate of zinc (gr. ij to an ounce), and an injection made as follows: zinci sulph. ℈j.; liq. plumbi diacetatis ʒj; aq. ad ℥x. Nitrate of silver of the strength of $\frac{1}{4}$ to $\frac{1}{2}$ gr. to the ounce is frequently used, but it causes more pain than the other injections, and a further objection to its use is that it stains the linen. There are several points to be noted in the use of injections in gonorrhœa. They should never be used strong, but should be used frequently, four or five times a day. The same injection should not be employed for too long a time; if no decided effect is produced in a week or ten days, it should be changed for some other. The patient should always be instructed to pass water before injecting; this washes away any discharge which may have collected in the canal. The nozzle of a half-ounce glass syringe is introduced into the orifice of the urethra, and the finger and thumb of the left hand compress the glans penis against it. The piston is then slowly pushed home and the fluid injected. It is allowed to remain in the urethra for about half a minute; the nozzle is then withdrawn and the fluid escapes. A useful mode of applying antiseptics to the urethra is in the form of bougies. The best of these is the iodoform and eucalyptus bougie. It is made of iodoform gr. v; eucalyptus oil ♏x; oil of theobroma gr. xxxv. The patient first passes water, and then the bougie, which has been previously lubricated with carbolic oil, is rapidly pushed into the urethra, until it has entirely disappeared, and a pad of antiseptic wool is tied over the end of the penis. The bougies are usually made of the length of four inches, but a longer one may sometimes be employed with advantage. After the insertion of the bougie, the patient should refrain from passing water as long as possible. A bougie may be applied every other day, and in the intervals the patient should use some mild astringent injection. During the treatment of this stage of gonorrhœa, the patient must lead a regular life. His diet should be plain and unstimulating, and as a rule alcohol in any form should be prohibited. He should avoid all severe exercise and fatigue. It is advisable that he should wear a suspensory bandage.

Various attempts have been made at different times to cut short an attack of gonorrhœa in its early stages by abortive treatment. Perhaps the most feasible plan is that recommended by the late Mr. Cotes. After the patient has passed water, a solution of cocaine is injected. An endoscope is then introduced, and the posterior limit of the inflammation is defined. A swab soaked in a 10 or 20 gr. solution of nitrate of silver is passed down the tube of the endoscope, so that it projects beyond the end of the tube and therefore beyond the limit of the inflammation. The swab and endoscope are withdrawn together. The patient is kept quiet for twenty-four hours, and then uses a weak boracic lotion as an injection.

The treatment of gleet is often very difficult and disappointing. The patient may fancy himself cured, and then sexual intercourse, or a little excess in eating or drinking, will bring back the discharge. Gleet is very likely to occur in the rheumatic, gouty, or tuberculous subject, and these constitutional conditions should always be sought for, and, if found, treated. Otherwise the patient should be enjoined to keep regular habits; to abstain entirely from sexual intercourse, and to avoid all excesses of eating and drinking. In some cases entire abstinence from alcoholic liquids is necessary; in others the patient appears to derive benefit from a glass of stout or a couple of glasses of claret with his dinner. Change of air, especially sea air, is often beneficial. If the patient is anæmic, tincture of the perchloride of iron should be given internally, care being taken to prevent constipation. The local treatment consists in the injection of the various solutions which have been mentioned above, but as a rule it is desirable to use them rather stronger in the gleety stage. A full-sized bougie should be passed once or twice a week. If these measures do not succeed, and there is reason to believe that a granular patch has formed in the urethra, an endoscope must be introduced and the patch mopped with a strong solution of nitrate of silver (10 or 20 grs. to ℥j). The patient must be kept strictly at rest after the application, as otherwise it is likely to be followed by swelled testicle or abscess in the perineum.

Complications of gonorrhœa.—The complications which may follow a gonorrhœa are very numerous.

1. They may be due to the direct extension of the inflammation, which may set up (*a*) balanitis, (*b*) suppurating bubo, (*c*) urethral abscess,

(*d*) inflammation of Cowper's glands, going on to suppuration. It would appear to be probable that these conditions are due to pyogenic organisms, which are associated with the gonococci.

a. **Balanitis** usually occurs in individuals who have a long and tight prepuce; it is characterised by considerable swelling and œdema of the foreskin, and it is in these cases that inflammation of the lymphatics of the penis and (*b*) **suppurating bubo** ensues.

c. **Urethral abscess** is due to infection of one of the lacunæ of the urethra. A suppurative form of inflammation is set up, and a tense rounded swelling forms, which is very painful, and may press upon the urethra so as to occlude the passage and produce retention. It may burst into the urethra or externally. If the former, a subsequent opening usually forms externally, and a fistula is produced, which is often difficult to heal. These abscesses should therefore be opened early, when they usually heal without difficulty.

d. **Inflammation of Cowper's glands** causes a hard, tender swelling in the perineum, which rapidly runs on to suppuration. If not opened early the matter tends to burrow laterally, being bound down by the dense perineal fascia.

Inflammation of the prostate gland and of the **bladder** are other complications of gonorrhœa due to direct extension, which have been already described; while another complication, **inflammation of the epididymis,** will be considered in the chapter on Diseases of the Male Generative Organs.

2. Complications of gonorrhœa may arise from the poison being conveyed to distant parts, as in gonorrhœal **conjunctivitis,** where the disease is believed to be set up by the direct transmission of the virus to the conjunctival sac by the hand of the patient; and in gonorrhœal **proctitis,** which occurs in females from infection with the discharge which escapes from the vulva.

3. Finally, complications of gonorrhœa may arise from the absorption of the virus by the blood and its conveyance to other parts of the body. This is seen in cases of gonorrhœal **rheumatism,** which has already been described (page 535), and in cases of gonorrhœal **sclerotitis,** which is a rare affection, usually associated with gonorrhœal rheumatism.

Gonorrhœa in the female is a less severe affection than in the male, but at the same time is liable to be followed by dangerous consequences. The disease primarily affects the vulva and vagina, and may be confined to these parts. The urethra is implicated in only about one case in five; but Bartolini's glands are liable to become involved, and may suppurate. In some cases the disease spreads to the uterus and Fallopian tubes, and purulent salpingitis may be set up. Inflammation of the ovaries and peritonitis may also be consequences of this disease. In the early stages there is swelling and redness of the vulva, and an abundant purulent discharge, with pain during micturition, and the disease is easily recognised; later on it is almost impossible to diagnose it from leucorrhœa, but by examination with a speculum it will be found that in leucorrhœa the discharge comes from the interior of the uterus, whereas in gonorrhœa, for the most part, the uterine orifice is free from discharge, which comes from the vaginal wall.

The **treatment** of gonorrhœa in females consists, in the acute stage, in the administration of warm hip baths, rest in bed, low diet, and the frequent irrigation of the vagina with an abundant weak astringent injection.

Later on, when the disease has become chronic, the irrigation should still be continued, and between the periods of irrigation pledgets of wool soaked in glycerine of tannin should be introduced into the vagina and between the vulva.

Urethritis from injury.—Inflammation of the urethra may be excited by the passage of a catheter, or by a stone expelled from the bladder along the urethra. In these cases there is a history of pain during micturition immediately following the injury, and this is succeeded by swelling of the lips of the urethra and a muco-purulent discharge. The condition may be complicated by epididymitis, or by inflammation of the bladder or prostate. The case should be treated by rest, diluents, an aperient, and the administration of five minims of tincture of belladonna in camphor mixture every four or six hours.

Gouty urethritis.—Inflammation of the urethra is occasionally set up in a gouty subject. It is characterised by great irritability of the bladder, scalding on passing water, and a small amount of purulent discharge, occurring in a patient in whom there is a history of gout. In some cases it may be due to an eczematous condition of the glans penis, which spreads to the urethra. Under these circumstances the glans penis and orifice of the urethra are bright red, and there is a milky white discharge. The **treatment** consists in attending to the gouty condition.

Tuberculous urethritis.—This form of the disease usually attacks the prostatic portion of the urethra and the neck of the bladder. There is a scanty discharge, which is often bloody, and there is severe burning pain and spasm in the perineum after the passage of urine. The disease rapidly spreads to the bladder, when the irritability of the organ becomes excessive, the patient wanting to pass water constantly, and the urine becomes fœtid and ammoniacal. The disease may spread to the kidneys by the ureter. The **treatment** consists, in the early stage, of the general treatment for tuberculosis; after the bladder becomes involved the treatment is the same as for tuberculous bladder (page 957).

Stricture of the urethra.—By the term *stricture of the urethra* is understood a persistent diminution in the calibre of the canal, from a deposit of lymph within its walls; this becomes organised, and by its subsequent contraction causes a reduction in the lumen of the tube.

Causes.—(1) Gonorrhœa. The inflammation set up in the mucous membrane by the infective organisms spreads to the submucous tissue, and is attended by the pouring out into this tissue of an inflammatory exudation, which becomes organised and converted into dense fibroid or scar tissue, and forms a firm hard ring or band around the tube. This, like scar tissue elsewhere, contracts, and so the stricture is formed. (2) Traumatism. A rupture of the mucous membrane takes place as the result of injury. Lymph is effused to repair the injury, becomes converted into cicatricial tissue, which contracts, and forms a stricture. (3) Ulceration of the mucous membrane of the urethra causes stricture. This form of stricture usually occurs near the orifice, and is for the most part the result of a urethral chancre; this, in the process of healing, forms scar tissue, which by its contraction causes stricture. (4) Urethritis from other causes besides gonorrhœa may be followed by stricture. The manner in which it is caused is the same as in those cases where it is the result of gonorrhœa. Sometimes, when there is no evidence of any stricture, a patient may be attacked with retention of urine from spasm of the muscular coat of the urethra, or from congestion of the mucous membrane. This has induced some authors to describe stricture of the urethra under three different heads -as *spasmodic stricture*, *congestive stricture*, and *organic stricture*; but the two former of these conditions cannot rightly be regarded as stricture, as there is merely temporary obstruction and retention; though it frequently happens that these conditions are set up in cases where there is a slight degree of organic stricture, not sufficient to produce any marked symptoms, and to this the spasm or congestion is superadded. It will be convenient to consider these two conditions first.

Spasmodic stricture.—The so-called *spasmodic stricture* occurs in those cases where there is some irritation of the mucous membrane of the urethra, and the exciting cause of the spasm is usually too free indulgence in drink or exposure to wet and cold, whereby the action of the skin is suspended. A patient, who possibly may be suffering from some slight stricture of the urethra, which has not produced any marked symptoms, or who is suffering from an irritable condition of the urethra from too great sexual indulgence, or too high living, after a debauch, suddenly finds himself unable to pass water. The bladder is full and the desire to micturate is urgent, and he is in great pain. The bladder may be seen, in thin persons, as an oval tumour in the lower part of the abdomen, which is dull on percussion. The **treatment** consists in administering a hypodermic injection of morphia (gr. $\frac{1}{3}$) and in placing the patient in a hot bath (105° F). This will generally be all that is necessary, and the spasm will relax as the patient becomes somewhat faint in the bath and the opium begins to take effect, and he will pass his water. Should this not be so, he should be placed under the influence of an anæsthetic, and there will then be usually no difficulty in passing a full-sized catheter.

Congestive stricture.—In this condition the obstruction to the flow of urine is due to the swollen state of the mucous membrane of the urethra. It occurs in gonorrhœa and in gouty subjects where the mucous membrane is inflamed and swollen to such an extent as to occlude the canal. In these cases, in addition to the inability to pass water, there is swelling and redness of the lips of the urethra and a more or less abundant purulent discharge. The **treatment** consists in the introduction of a soft instrument with great care and gentleness. This will usually be attended by some hæmorrhage, which will act beneficially by diminishing the congestion.

Various terms are applied to **organic strictures** according to their physical characters: an *annular* stricture is the most common form, and, as the name implies, is one in which a narrow rim of cicatricial tissue encircles the whole lumen of the tube. An *indurated* stricture is where a considerable portion of the wall of the urethra is involved in a dense mass of cicatricial tissue. This form of stricture may be also *tortuous*, when there is more deposit on one side than the other, so that the canal is deflected and not straight. A peculiar form of stricture is the *bridle* stricture (fig. 382), where a band stretches across from one side of the urethra to the other: the mode of causation of this form of stricture is not very clear, but it is believed that it is produced by a perforation of an annular stricture by the point of the catheter. An *irritable* stricture is a term applied to those cases where the passage of an instrument is frequently followed by a rise of temperature, with chills or rigors. The term *resilient* or *elastic* stricture is applied to one which can be rapidly dilated, and as rapidly contracts. A *permeable* stricture is one which permits of the introduction of an instrument; while an *impermeable* is one in which the surgeon is unable to pass an instrument. In the true sense of the word, no stricture of the urethra where the mucous membrane remains intact is impermeable; a passage always exists, though it may not be possible to introduce an instrument through it. In strictures, however, which result from traumatic causes, where the mucous membrane has been lacerated, and in those which result from ulceration of the mucous membrane, the canal may be entirely closed, and the patient compelled to pass his water through a fistulous opening communicating with the urethra behind the stricture.

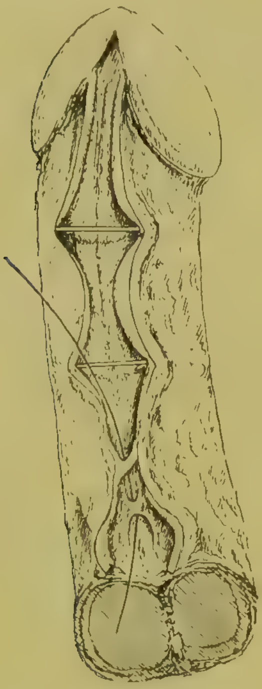

FIG. 382.—Bridle stricture of the urethra. (From the Museum of St. George's Hospital.)

The locality in which a stricture is found varies considerably, but it is much more common in front of the triangular ligament than behind it. Strictures never occur in the prostatic urethra, and only rarely in the membranous portion. In the opinion of many surgeons, the most common situation for a stricture is in the bulbous portion of the canal, but Berkeley Hill and Otis state that in their opinion they are more frequently found in the penile division of the urethra. There seems to be an anatomical explanation for the fact that stricture is very common in the bulbous portion of the urethra; for here the sub-mucous tissue is much more abundant than in any other part of the canal, and being abundant, soft, and vascular, a large amount of lymph is effused into it, which by its subsequent contraction causes the stricture.

Consequences.—The consequences of a stricture are very serious, and it may be said that a neglected stricture will almost certainly cause the death of a patient, if he only lives long enough for the pathological changes which follow in its train to take place. These changes are slow but sure, and occur in the urethra behind the stricture, in the bladder, the ureters, and the kidneys. The urethra behind the stricture becomes dilated, on account of the tension to which it is exposed during the act of micturition (fig. 383). Its walls become thinned and inelastic, and the mucous membrane of an ashy grey colour. The dilatation may be so great as to form a distinct pouch, in which phosphatic deposits may collect, or the walls of which may ulcerate and an abscess form, which slowly reaches the surface and bursts or is opened, and a perineal fistula is established. In cases where retention occurs, the dilated portion of the urethra behind the stricture may suddenly give way and extravasation result. The muscular coat of the bladder becomes hypertrophied, from the increased force which is required to expel the urine through the narrowed urethra. There is always a certain amount of cystitis, and the walls of the bladder become unyielding and inelastic, and its cavity diminished, on account of the irritability from the cystitis, which never allows the bladder to become distended to its normal capacity. From the tension to which the organ is subjected during the act of micturition, the mucous membrane is bulged out in places between the muscular fasciculi, and the bladder becomes sacculated. Urine is contained in these saccules, and is not voided because they have no muscular walls; it decomposes, sets up inflammation and suppuration, and they become abscess cavities; or the walls of the saccules may ulcerate, and extravasation takes place into the cellular tissue outside the bladder, or phosphatic concretions may form in them. Occasionally, where there is retention, the bladder becomes dilated and thinned, and its overstrained walls lose their power of contractility. The ureters become dilated (fig. 384), from obstruction to the escape of the urine into the bladder, on account of that part of the ureter which perforates the muscular coat

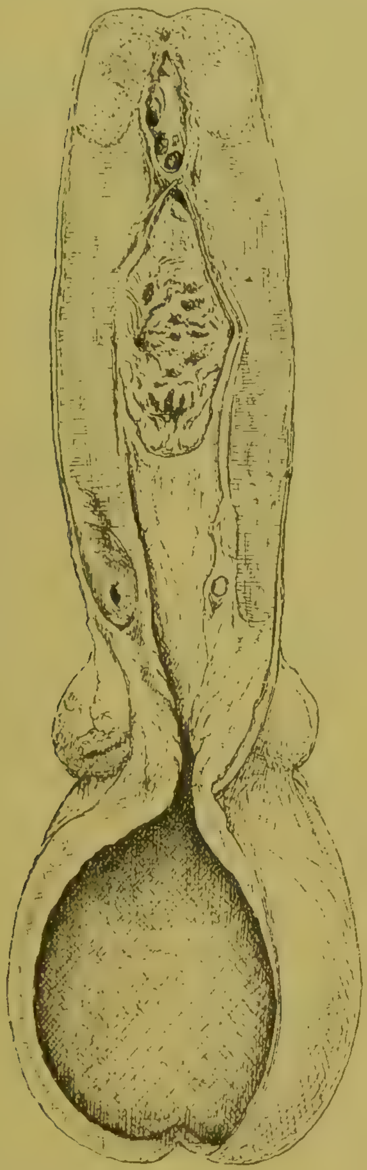

FIG. 383.—Stricture in the penile portion of the urethra, showing dilatation of the urethra behind the stricture. (From the Museum of St. George's Hospital.)

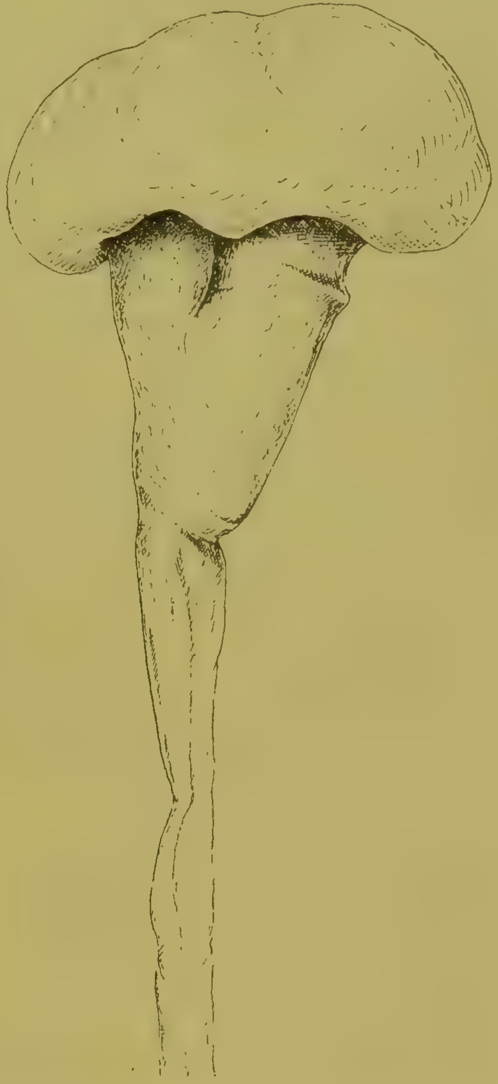

FIG. 384.—Dilated ureter from stricture of the urethra. (From the Museum of St. George's Hospital.)

being compressed by the hypertrophy of the muscular fibres and the rigid coats of the bladder. Not only do the ureters become dilated, but also the pelves and calyces of the kidneys, and this dilatation takes place at the expense of the secreting structure. Later on, septic matter finds its way from the bladder up the ureters to the kidneys, and inflammation and suppuration occur in these organs, leading to the so-called *urinary cachexia* and a fatal result.

Symptoms.—In many cases of stricture the patient will first present himself complaining that he is suffering from a little gleety discharge, and on inquiry it will be found that he has a frequent desire to pass water, and some little difficulty or hesitancy in doing so ; and that there is a certain amount of pain in the perineum during the act of micturition. He may have noticed also that the stream of water is smaller than it used to be ; that it is sometimes forked or spiral ; that he takes longer over the act of micturition, and that after he has adjusted his dress, a few drops of urine are apt to escape. Under these circumstances a physical examination should be made, as the only means of actually establishing a diagnosis. Later on, when cystitis has been set up, the character of the urine is changed ; it is alkaline, and loaded with mucus and phosphates. The stream becomes still smaller, and there is increased difficulty and delay in micturating. The desire to do so is more frequent, and the rest is disturbed by frequent calls to pass water. Pain is experienced above the pubes, especially on pressure. The digestion is impaired, the nutrition fails, and the patient becomes weak and anæmic. Finally, when the urinary cachexia becomes well marked, there are attacks of feverishness, vomiting, and diarrhœa, the appetite is lost, the tongue becomes dry and coated, there is great thirst and aching pain in the loins, and the patient succumbs to uræmic poisoning.

The existence of a stricture can only be absolutely determined by a physical exploration of the urethra. This is done by means of a catheter or sound, which is passed down the urethra till it meets with the obstruction. It must be borne in mind that the meatus is the narrowest part of the urethra, and any instrument which will pass through it ought to pass along the whole canal if there is no contraction. Considerable difference of opinion exists among surgeons as to the best form of instrument to use. Formerly metal catheters or bougies were almost always used for exploration, but they are much more irritating and painful to the patient than a softer instrument, and therefore it is desirable not to employ them if the necessary information can be obtained without their use. The great advantage which they possess is that they can be more easily located, and the exact position of the point of the instrument defined in the urethra. They can also more easily be maintained aseptic. The best form of soft catheter to use is the silk web aseptic catheter with solid end. These are polished and prepared on the inner surface of the tube as well as outside, and can therefore be more easily cleaned and rendered aseptic. An instrument should first be selected which passes easily through the meatus, and having been warmed and well lubricated should be introduced rapidly but gently down the urethra until it meets with the obstruction. By measuring off the length of the instrument in the urethra, the position of the stricture can be ascertained. If the catheter will not pass through the stricture, a smaller and smaller instrument should be tried until one is found small enough to pass through. The amount of contraction can in this way be gauged. Otis has invented a urethrometer by which the actual size of the stricture can be ascertained and is registered on a dial fixed to the handle, but for all practical purposes the size can be gauged with sufficient accuracy by using a graduating series of instruments. Harrison recommends for the exploration of a stricture a flexible conical bougie, about twenty inches in length, commencing with a fine probe-ended extremity, which gradually expands in the opposite direction. This coils up in the bladder as it is passed, and by this means the degree of contraction can be ascertained. Occasionally it will be found that the smallest sized catheter cannot be introduced. Under these circumstances a fine catgut bougie may be tried, which will sometimes find its way through a tortuous stricture when all other instruments have failed ; but should this fail, the patient should be placed in bed for two or three days and be kept on somewhat low diet, ordered a dose of sulphate of magnesia every morning, and a hot bath each night. At the end of this time a second attempt may be made under an anæsthetic.

In passing a metal instrument the surgeon should stand on the left side of the patient, who should be lying flat and perfectly straight on a bed. This leaves the left hand of the operator free to hold up the penis, to guide the point of the catheter in the perineum, or even, if necessary, to pass the forefinger into the rectum, as a guide to the passage of the instrument. The patient's abdomen should be uncovered, so as to expose the umbilicus, which is a useful guide to the surgeon in passing the instrument. The catheter should be well warmed and oiled with some antiseptic oil. Lund's oil is perhaps as good as any. It is composed of olive oil, 15 parts, castor oil 4 parts, and carbolic acid 1 part. The penis being directed towards the left groin, and held between the forefinger and thumb of the operator, the point of the catheter is introduced into the meatus and allowed to find its way, principally by its own weight assisted by a little pressure from the hand of the surgeon, into the perineum. As this is being done the penis and catheter are made to describe a segment of a horizontal circle inwards, so that by the time the point of the catheter has reached the perineum, the handle is in a line with the umbilicus. Still continuing its passage onwards, the handle of the catheter is raised from the body of the patient until it is vertical, and then finally is depressed between the patient's thighs, as the point, finding its way under the arch of the pubes, enters the bladder. No force is required, and the catheter finds its way along the urethra mainly by its own weight. Occasionally in a sensitive urethra, a certain amount of spasm may be set up and the onward progress of the catheter is arrested. If this takes place, it is better to wait for a minute or two and make no further efforts until the spasm has passed off.

In passing a soft, flexible catheter without a stilette, it is only necessary to pass the instrument straight onwards, with a little rotatory movement, until it reaches the bladder. It will find its own way under the arch of the pubes. It is better to elongate the penis with the forefinger and thumb, so as to tense the mucous membrane, and prevent the point of the catheter hitching against any fold.

In making this exploration of a stricture it must always be borne in mind that the passage of an instrument, especially for the first time, in a patient with a stricture whose kidneys are presumably not in as healthy a condition as could be wished, is always a serious matter. It should never be done in the consulting room of the surgeon, but the patient should be in bed, and should be enjoined to remain there for the rest of the day, well covered up with blankets, for fear a rise of temperature, and perhaps a rigor, should supervene. His bowels should have been well opened beforehand, and he should be directed not to pass his water for some time afterwards. If the temperature begins to rise, or symptoms of rigor set in, five grains of quinine and a cup of hot beef tea should be given.

Dangers of catheterism.—In addition to the dangers of shock and urethral fever from passing a catheter, there are other dangers which must be borne in mind. In all operations on the deeper part of the urethra there is always a certain amount of reflex action on the kidneys, which causes congestion of these organs; and if they are diseased, as they often are in cases of stricture, suppression of urine may result. Local troubles may also be set up by the passage of an instrument. Urethritis and cystitis have already been alluded to, and not uncommonly inflammation in the urethra may extend down the vas deferens, and a condition of epididymitis be set up. Hæmorrhage may occur from the passage of an instrument. This is usually from abrasion of the mucous membrane by the point of the catheter, and is to be avoided by using the greatest care and gentleness; but in other cases where the mucous membrane is congested a certain amount of bleeding cannot be avoided. It is never very severe, and usually stops of itself in a short time. False passages may be produced by the too violent use of the catheter, the point of the instrument finding its way out through the coats of the urethra into the surrounding tissues. They are especially liable to occur where a small metal instrument is used. They partake of the character of a lacerated punctured wound, and usually take a direction downwards and to one side; they may, however, be directed downwards, without any lateral deflection, and after traversing the tissues for a certain distance, may re-enter the canal; they are not then attended with so much danger. When, however, they are deflected to one side, they may enter the loose areolar tissue between the rectum and bladder, and then serious consequences may ensue from inflammation and abscess around the neck of the bladder. The occurrence of a false passage is at once indicated by the surgeon feeling, at the moment he is making some little effort to introduce the instrument, a sudden onward movement, and a deflection of the handle of the catheter to one side. This is attended by a sudden pain, and probably the patient cries out, and blood issues from the urethra. On introducing the finger into the rectum the point of the catheter will be felt too near the bowel, below the prostate. In some cases the instrument has been pushed through into the rectum.

In order to avoid making a false passage, it cannot be too strongly insisted upon that no force should ever be employed in passing a catheter. The point of the instrument should be always kept towards the roof of the urethra, as false passages are generally made through the floor of the canal. If the surgeon is aware that he has made a false passage, he should desist from any further attempt to introduce an instrument, unless retention is present, and should desire his patient to abstain from attempting to pass water as long as he can, in order that the wound may become glazed before any urine passes over it. No attempt should be made to pass a catheter again for some days until the wound has healed.

Treatment.—The treatment of stricture of the urethra must be considered under two heads: first, the treatment of the common form in which strictures are met with, where a catheter can be introduced into the bladder; and secondly, the treatment of those cases where it is impossible to pass an instrument.

Treatment of permeable stricture.—The treatment of a permeable stricture of the urethra may be conducted in several different ways: (1) By gradual interrupted dilatation; (2) by gradual continuous dilatation; (3) by forcible rupture; (4) by electrolysis; (5) by internal urethrotomy; (6) by external urethrotomy; (7) by excision. It must be borne in mind that by none of these methods can a permanent cure be brought about, except, perhaps, in very recent cases, where the inflammatory exudation has not yet been converted into cicatricial tissue, but that a stricture having once formed will always remain, and, unless prevented by appropriate treatment, will always have a tendency to contract and reproduce the obstruction. The treatment aims at dilating the canal to its normal calibre, and then keeping it so dilated.

1. The **treatment by gradual interrupted dilatation** consists in passing instruments of increasing size at short intervals. This is the usual and most successful mode of treating an ordinary stricture. It excites the least irritation, and can be carried out without interfering with the patient's pursuits or occupation. It aims at promoting absorption of the inflammatory products, which have been effused into and under the mucous membrane, and is therefore particularly suitable to recent strictures. It is also the best plan of treatment in cases of stricture where the kidneys are diseased, as it is safer than any other procedure. The plan of proceeding consists in passing the largest instrument which at the preliminary examination of the stricture was found to pass without using any degree of force. After it has been passed it is allowed to remain in the bladder for about five minutes and is then gently withdrawn. If the introduction has not been attended by any sensation of faintness and nausea, and the patient at the first introduction suffered from no shock or urethral fever, he may be allowed to go about at once; but if there are any unpleasant symptoms caused by the passage of the instrument, he should remain quiet for a few hours, warmly covered up until these symptoms have subsided. On the second or third day the same instrument should be again introduced, and if it passes with ease, it should be at once withdrawn, and the next larger size introduced and allowed to remain in for five minutes. If there is still some difficulty in passing it, it is as well not to attempt the introduction of a larger instrument. This proceeding is continued, an instrument being passed every second or third day, and the augmentation in the size of the instruments being very gradual. In this way a stricture may be gradually dilated to admit a No. 12 English size catheter in the course of a few weeks, and after that the patient may be taught to pass an instrument for himself, with instructions that he is to do so once a week for a twelvemonth, and after that probably once a month for the rest of his life. If this is not done the stricture will assuredly recontract. As far as possible it is desirable that these proceedings should be carried out with soft flexible catheters. They cause less pain and irritation, and there is not the same risk of making a false passage. When, however, the stricture is very tight and of long standing, it is sometimes impossible to introduce a soft catheter, and then a metallic instrument must be used. Probably the best form is Lister's conical steel bougie, and it should be used with every possible care and gentleness. After the stricture has been dilated by means of these instruments up to a certain point, the further treatment may be conducted with an ordinary soft catheter. On no account whatever should a patient be entrusted with a metal instrument to pass on himself.

2. The **treatment by gradual continuous dilatation** consists in passing a catheter through the stricture and tying it in, so that the end lies just within the bladder. In the course of a day or two it will be found that the catheter lies quite loose in the stricture, and it must then be removed, and a larger one inserted. In this way the stricture can rapidly be dilated. This plan of treatment is particularly applicable to very tight strictures where, perhaps, only the smallest instrument can be introduced with the greatest difficulty under anæsthesia. In such a case, after the instrument has been introduced it should be tied in, and in this manner the stricture may be dilated up so as to admit a No. 5 or 6 catheter in a week. It necessitates keeping the patient in bed, and is therefore applicable principally to hospital in-patients, whom it is desirable to cure as quickly as possible, and who, while in hospital, can be confined to bed. The treatment is not, however, without its risks, and cystitis is very liable to be set up by the constant presence of the catheter ; and if care be not taken to prevent the catheter lying too far in the bladder, the pressure of the point of the instrument may cause ulceration of the coats of the viscus, and even, as in one case which came under my own notice, actual perforation. The catheter is best held in position by tying the centre of a piece of tape round the handle of the instrument, and then bringing the two ends down either side of the body of the penis, and fixing them there by means of a piece of strapping which is made to encircle the penis, care being taken not to put it on so tightly as to produce strangulation. The catheter is closed with a wooden plug, which the patient can remove whenever he desires to pass water. In the course of a day or two some of the urine will pass by the side of the catheter, and probably there will be a little discharge from the urethra.

3. **Forcible rupture**, by which is meant forcibly rupturing or tearing the stricture by means of some expanding instrument. This is a plan which has had many advocates, but happily now has almost entirely fallen into disuse, as it is attended with very considerable risk, and though it may succeed in restoring the urethra to its full diameter in the course of a few minutes, this can only be accomplished at considerable peril to the patient's life, and can after all only bring about in a few moments what can equally well be done by gradual dilatation in a few days without any appreciable risk to the patient. The dangers of this operation are, first of all, shock, which may sometimes be severe, and in many cases has been followed by suppression of urine, and the death of the patient ; secondly, it is not unfrequently followed by urinary abscess, and in some cases this has led to pyæmia. The operation has now, therefore, been practically abandoned, and need not further be discussed.

4. **Electrolysis** consists in destroying the scar tissue which constitutes the stricture by an electric current. To the end of the negative pole of the battery is attached a flexible catheter terminating in a metal tip. This is passed down to and pressed against the stricture. The positive pole, to which is attached a sponge or wet pad, is placed on the back. The strength of the current should not be more than 5 milliampères. After the current has been passed for some time, it may be for half an hour, the catheter will pass through the stricture. The proceeding as a rule causes little or no pain, but may require repeating two or three times, each time using a larger electrode. This treatment has recently been revived by Swinford Edwards, Bruce Clark, and others, and is highly spoken of by them, but at present we have no accurate data as to whether there is the same

tendency to relapse after this method of treatment as there is after gradual dilatation.

5. **Internal urethrotomy** consists in dividing the stricture from within the urethra. It is an exceedingly useful mode of treating certain classes of stricture which are not amenable to treatment by ordinary dilatation. Among these may be mentioned : (1) the resilient stricture, which is highly elastic, and can be dilated with the greatest ease, but as quickly contracts again ; (2) the hard, dense, so-called cartilaginous stricture, which resists all attempts at gradual dilatation ; (3) the bridle stricture, which cannot be treated by dilatation ; (4) the irritable stricture where the patient suffers from an attack of urethral fever after every attempt to pass a catheter ; (5) internal urethrotomy is also suitable for the treatment of strictures close to the external meatus. There are two ways in which the operation may be performed, either by dividing the stricture from behind forwards, or by dividing it from before backwards. The former plan is usually stated to be the better, because it is said that the surgeon by this means is able to gauge the amount of tissue divided ; but this plan of operating can only be adopted when the stricture is sufficiently dilated to admit a urethrotome equal in size to a No. 5 English catheter. A very ingenious form of urethrotome was invented by the late Mr. Berkeley Hill, in which the cutting knife is concealed in a wedge-shaped block, and by means of this the stricture can be divided from before backwards, without any risk of cutting anything but the stricture. The accompanying illustration will give some idea of the general construction of the instrument (fig. 385). The conducting sound is first passed, and the urethrotome is connected to it by means of the screw at the end, and is guided by it through the stricture. The wedge which contains the concealed knife is now inserted between the blades of the instrument, and is pushed down until it reaches the stricture and cannot be pushed any further. The wedge thus dilates the walls of the canal in front of the stricture, and keeps them out of the way, while by means of the button at the end of the instrument the concealed knife is made to protrude from the wedge and divide the stricture, and the stricture only. The wedge can now be pushed onwards, and this should be done in case there may be a second stricture. After all the strictures have been divided, the instrument is withdrawn and a No. 12 (English) catheter is passed, to see that the whole length of the urethra is pervious, and to empty the bladder. The patient should be wrapped up warmly in blankets, and enjoined not to attempt to micturate for eight hours. He should then be placed in a hot bath, and pass his water while in the bath. An hour after the urine has been passed the temperature should be taken, and if it is above normal five grains of quinine should

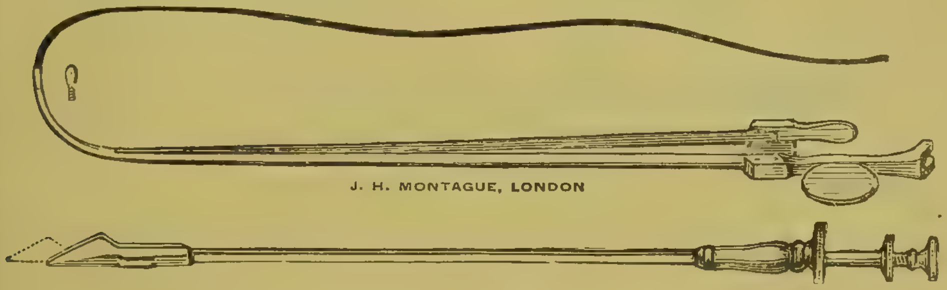

FIG. 385.—Berkeley Hill's urethrotome.

be given. Prior to commencing the operation it is advisable to wash out the urethra and bladder with boric acid solution. No instrument should be used for ten days afterwards, and then a full-sized bougie should be passed, and the operation repeated once a week for a time. After which the patient must be taught to pass an instrument for himself, and be enjoined to do so once a month for the rest of his life.

6. **External urethrotomy.**—This operation, known as Syme's operation, is now rarely performed, as many of the cases for which it was formerly employed are treated by internal urethrotomy. It is practically reserved for those cases of old and hard stricture in the deeper part of the urethra, which are complicated by urinary fistulæ. A special instrument, known as Syme's staff, is required for the performance of the operation (fig. 386). This consists of a staff, the distal end of which is of small size, equal to about No. 2, and is grooved on its convex surface. This joins the rest of the instrument about two inches from its extremity by an abrupt shoulder. The patient having been placed in the lithotomy position and the perineum shaved and cleaned, the staff is introduced and the small end passed through the stricture, so that the shoulder rests against the face of it. An incision is made in the middle line and deepened until the staff can be felt at the bottom of the wound. The point of the knife is inserted into the groove in the staff close to the shoulder, and therefore opens the urethra just behind the stricture and is carried forwards along the groove to its anterior extremity, and in this way the stricture is divided. In doing this great care must be observed to keep strictly in the middle line, and not allow the point of the knife to slip out of the groove. Any fistulæ which may exist are now to be opened up into the median wound, scraped and swabbed out with pure carbolic acid or chloride of zinc solution. A full-sized soft catheter is introduced through the urethra into the bladder and tied in, and the wound packed with antiseptic gauze and allowed to granulate up from the bottom. The catheter should generally be removed on the second day, and a full-sized instrument passed every other day until the wound has healed.

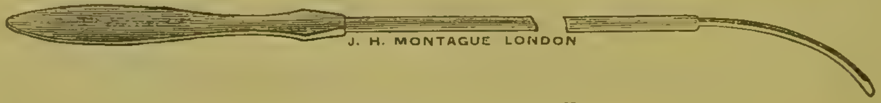

Fig. 386.—Syme's staff.

7. **Excision** barely requires mention, as it can only be rarely required. The only cases for which it would seem to be applicable are inveterate traumatic strictures in the penile portion of the urethra, which have resisted all other plans of treatment. The operation is performed by exposing the urethra by a median incision, and excising as much as possible of the indurated tissue, and if possible suturing the cut ends of the canal together. When the stricture is in the penile portion of the urethra this is comparatively easy; but in the deeper parts the chances of affording relief are so slight that the operation cannot be advised.

Treatment of impermeable stricture.—Because a surgeon is unable to pass any instrument through a stricture on the first or second time that he attempts to do so, he must not therefore regard the case as one of impermeable stricture. As a matter of fact, impermeable strictures, except those resulting from injury, are comparatively rare, and by patience and care the surgeon can in many instances succeed in passing an instrument in a case which has perhaps too hastily been regarded as one of impermeable stricture. In the event of the surgeon failing to introduce an instrument on his first attempt, the patient should be strictly confined to bed, on a light diet; have a hot bath every evening; and a dose of Epsom salts each morning. After this treatment has been persevered in for a week or ten days, another attempt should be made under anæsthesia to pass an instrument, and with patience the surgeon will, in the great majority of cases, succeed in overcoming the difficulty. Even if he only succeeds in introducing the finest catgut bougie a great point will have been gained. This may be left in the stricture, and the patient will probably succeed in passing his water by the side of it; if not, it must be taken out when he wants to micturate, but it will be found on the following day that the same bougie will pass with comparative ease, and by increasing its size from day to day the stricture may be dilated. When no instrument can be passed operative interference becomes necessary, and there are three modes of dealing with these cases: either by dividing the stricture from before backwards by Wheelhouse's operation, or by dividing the stricture from behind forwards by the old operation of 'la boutonnière' or perineal section; or by opening the urethra behind the stricture and allowing the patient for a time, or permanently, to pass his water through the artificial opening thus made. This is known as Cock's operation.

Wheelhouse's operation is difficult in performance, but is undoubtedly the most efficient of the three. For its performance two special instruments are required—a straight staff with a groove on one side and a blunt hook at the end opposite the groove, and a small gorget. The patient is placed in the lithotomy position, with the pelvis well raised, in a good light. The staff is introduced down to the stricture, with the groove facing the operator, and a median incision is made in the perineum down to the staff and the urethra opened by cutting into the groove in front of the stricture. The staff is then turned round, so that the hook at its end may catch in the anterior extremity of the incision in the urethra, and then by pulling on the staff the incision can be brought into view. After sponge pressure has stopped all hæmorrhage, the edges of the incision in the urethra are seized with sharp hooks and drawn apart. If the light is good, the aperture of the stricture will now be seen, and a probe-pointed director is inserted into it and passed through the stricture, which is then divided by a knife carried along the groove in the director. A small gorget is then passed and the director removed. Guided by the gorget, a full-sized catheter is passed down the meatus and tied in the bladder, where it is allowed to remain for three days, and is then removed and passed daily. The wound is allowed to heal by granulation.

Perineal section consists in cutting down in the perineum and opening the urethra behind the stricture and then attempting to divide the stricture from behind forwards. The operation is thus performed: A full-sized silver catheter is passed down the urethra as far as the stricture, and the patient is placed in the lithotomy position. The surgeon then passes the index finger into the rectum, and with the cutting edge of his knife directed upwards, introduces the point about half an inch in front of the anus in the middle line of the perineum, and divides the tissues directly upwards. This incision is deepened until the triangular ligament is reached. This will be recognised by the resistance which it gives to the finger introduced into the wound. When this structure is reached a soft and yielding point will be felt on it, about an inch below the symphysis pubis, in the middle line. This is the point where the urethra pierces the ligament, and the canal is usually dilated in this situation. The point of the knife is thrust through the triangular ligament at this spot, and the urethra is opened. A female catheter is now passed through the opening thus made, and can be pushed onwards into the bladder. The escape of urine through it will at once indicate that the urethra has been opened. The difficulty in the operation now commences. The surgeon introduces the point of his knife into the opening in the urethra and cuts forwards until he reaches the point of the catheter which has been passed down to the stricture. By this means he hopes to divide the stricture by following the line of the urethra, and by great good luck he may succeed in doing this; but it is far more probable that he will cut along the side of the urethra, leaving the stricture undivided. The catheter is now pushed onwards and, guided by the female catheter in the wound, is introduced into the bladder and tied in. If the surgeon has succeeded in opening the urethra all will be well, but if he has made a fistulous tract by the side of the urethra, it will most certainly contract, and the patient's condition will be in no wise bettered. The difficulties and uncertainties of the operation are so great that it ought to be abandoned.

Cock's operation closely resembles the preceding as far as the early steps of the operation are concerned, but in it no attempt is made to divide the stricture. An opening is made from the perineum into the urethra behind the stricture, and through this a straight tube is introduced into the bladder, through which the patient passes his urine. In many cases after all irritation has subsided it will be found that an instrument can be passed through the stricture and that then dilatation can be proceeded with in the ordinary way; but if not, Mr. Cock, who warmly advocated this operation, advises that the patient should be left to pass his water through the artificial opening for the rest of his life; the patient's mode of micturating being similar to that of the opposite sex. The artificial opening has a tendency to contract and requires the occasional passage of an instrument. The operation is thus performed: The patient is placed in the lithotomy position, and the surgeon introduces his left forefinger into the rectum and feels for the apex of the prostate. He then introduces a double-edged knife exactly in the median line of the perineum, about half an inch in front of the anus and pushes it with one thrust down to the point of his forefinger, which rests on the apex of the prostate. In withdrawing his knife he cuts upwards and downwards a little so as to make a triangular wound. By this means he opens the urethra just as it emerges from the prostate. As it is dilated in this situation on account of the stricture, the operation is not usually attended with any difficulty if the surgeon keeps strictly in the middle line. A broad director is now passed through the wound into the bladder, and along this a straight lithotomy tube is passed and tied in, and the director withdrawn.

Complications of stricture.—Stricture of the urethra may be followed by several local complications, of which the most common are: (*a*) Retention, (*b*) abscess in perineo, and (*c*) extravasation of urine.

Retention.—Retention of urine may occur in cases of stricture. This is very often the result of some spasm or congestion becoming superadded to the stricture, and these conditions have already been considered (page 997). But it may also occur in tight strictures from a gradual and progressive contraction. In these cases an attempt should first be made to relieve the patient by passing a small catheter, and very often the surgeon will succeed in doing this. If not, and the stricture is impassable, no time must be lost in relieving the patient. The best and simplest way of doing this is by aspiration above the pubes. The aspirating needle is passed directly into the bladder, immediately above the pubes, and the water slowly drawn off, care being taken to withdraw the needle before the bladder is completely emptied, lest the point of the needle should injure the coats of the bladder. After the little operation the patient should be kept quiet in bed and a morphia suppository administered. In the course of a few hours another attempt should be made to pass an instrument down the urethra, and all pressure having been removed from the posterior part of the urethra, this probably will succeed. If not, the bladder must be aspirated again when it becomes full, and the surgeon may have to do this several times before he will succeed in passing an instrument. It may happen, indeed, that he cannot succeed in getting any instrument into the bladder, and if after four or five aspirations have been resorted to he has still failed in introducing a catheter, Cock's operation should be performed. An alternative operation consists in tapping the bladder above the pubes and leaving the cannula in the wound, through which the bladder is drained. Cock's operation would, however, appear to be the preferable one, for when this is performed the patient after the first few days can be up and about, and has perfect control over the escape of his urine and is able to relieve himself with much more ease and comfort than through a tube above the pubes. In both operations it is probable that after a time an instrument will be got through the stricture, and it can then be dilated or divided ; but in some few cases this may not be so, and then the permanent opening is in a much more favourable place after Cock's operation than after the supra-pubic one. Cock's operation is especially indicated in those cases where, in addition to the retention, there is a hard brawny swelling in the perineum, indicating that some slight extravasation has taken place.

Abscess in perineo.—Occasionally it happens that the walls of the dilated urethra behind the stricture give way, and a small quantity of urine is extravasated into the tissues outside the urethra, but is strictly limited by inflammatory condensation around ; or the walls of the thinned pouch ulcerate and matter is formed, resulting in a small hard exquisitely painful swelling in the perineum. This is *abscess in perineo.* It is usually too small and deeply seated to permit of fluctuation being felt, but the presence of a stricture, and the formation of a hard exquisitely painful swelling, with feverish symptoms and perhaps a rigor, at once indicate the condition. No time should be lost in opening it by an incision in the raphé of the perineum ; for if not opened it will burrow its way to the surface, and, bursting through the skin, a long sinuous track will be formed, through which some of the urine will escape during micturition. In old standing neglected strictures there may be many openings, not only in the perineum, but also in the penis, scrotum, buttock and groin. The treatment of these cases has already been indicated (page 1006).

Extravasation of urine.—This takes place from giving way of the wall of the urethra behind the stricture. In consequence of the stricture there is an impediment to the flow of urine, and, if retention occurs, the patient makes violent efforts to empty his bladder; during one of these efforts a rent takes place in the urethra behind the stricture and the urine is driven with considerable force into the surrounding tissues. The portion of the urethra which almost always gives way is the membranous part ; that is to say, that portion of the urethra which lies between the deep layer of the perineal fascia (the fascia of Colles) and the triangular ligament. It will be remembered that these two fasciæ are continuous behind around the transversus perinæi muscle, and therefore the extravasated urine is unable to find its way backwards. Laterally both these fasciæ are attached to the ascending rami of the ischia, and the descending rami of the ossa pubis, and therefore the extravasated urine cannot find its way laterally on to the thighs. In front the triangular ligament is attached to the sub-pubic ligament, and therefore the inlet into the pelvis is closed; but the deep layer of the perineal fascia is continuous with the fascia of the scrotum and abdominal wall, and therefore the urine which is extravasated between these two layers of fascia must find its way forwards into the tissues of the scrotum and penis, and up on to the abdominal wall. When it reaches this latter situation it is prevented from travelling downwards on to the front of the thighs by the attachment of the deep layer of the superficial fascia of the abdomen to the fascia lata at Poupart's ligament.

It must be borne in mind that in these cases of extravasation of urine following retention from stricture, the extravasated fluid is by no means healthy. If the urine were healthy and aseptic, probably a greater part of it would be absorbed, and what remained might do little harm; but in these cases it is fœtid and ammoniacal, and acts as a virulent poison to the tissues into which it is extravasated, and the ravages it produces are great. The parts rapidly fall into a condition of gangrenous cellulitis, and speedy sloughing takes place.

Symptoms.—A patient, the subject of stricture, gets retention and makes violent efforts to empty his bladder. During one of these efforts he experiences a sudden pain in his perineum and a sensation as if something has given way. This is followed by a relief to his pain of retention, though he has passed no water. This feeling of relief is of short duration; tingling, followed by intense burning pain in the perineum and scrotum, rapidly supervenes, and the parts become swollen to a prodigious size, the swelling rapidly extending to the penis and up on to the abdominal wall. The skin at first is red, shiny, tense, and burning, but very soon becomes emphysematous and boggy. The discolouration assumes a dusky purple or black hue, and the skin gives way, exuding foul pultaceous sloughs, and a mixture of pus and urine of a most offensive odour. The local condition is accompanied by severe constitutional disturbance; fever of a low typhoid type, with a high temperature, a dry brown tongue, and a quick weak pulse. The patient becomes delirious with great depression and symptoms of profound toxæmia.

Treatment.—The treatment consists in at once making a free outlet for the escape of the urine from the bladder. The patient should be placed in the lithotomy position, and a free incision made in the middle line of the perineum through the infiltrated tissues until the urethra is reached. This must be freely opened in its dilated part behind the stricture, and a lithotomy tube introduced into the bladder and tied in. After this has been done, free incision must be made into all the swollen parts into which urine has been extravasated, so as to give exit to it and prevent as far as possible the destruction of the skin and subcutaneous tissues. These incisions must be carried deeply into the infiltrated tissues. When this has been done and all bleeding checked, the parts should be well sprinkled with iodoform and enveloped in hot boric fomentations or surrounded with charcoal poultices. The patient's strength must be supported by easily assimilated food, and stimulants and quinine should be given in large doses. If the patient survive, he will have to go through an exhausting process of separation of sloughs and healing of large granulating sores, and this with kidneys which are probably far from healthy, so that the prognosis in these cases is always most grave, for even if the powers of the patient enable him to survive the primary toxæmia, he will often subsequently succumb to exhaustion from the severe strain on his constitution produced by the profuse discharge and other sources of irritation which are set up.

Stone in the urethra.—Stones are occasionally impacted in the urethra, especially in boys. This is usually a stone which has been formed in the kidney, and having found its way down the ureter into the bladder, is passed with the urine and becomes impacted or fixed in the urethra. Stones may, however, form primarily in the urethra, and these are most usually phosphatic concretions forming in a pouch-like dilatation behind a stricture.

In the adult the presence of a stone in the urethra may be recognised by difficulty in micturition amounting sometimes to retention, and by feeling the stone either with a metal sound passed down the canal or by the finger through the walls of the urethra. They are most frequently lodged in the fossa navicularis or in the bulbous portion of the urethra. When in the former situation, they can be at once extracted by notching the meatus and prising it out with a director. When situated farther back, they may sometimes be worked forwards by manipulation with the finger and thumb under an anæsthetic. If not, an attempt may be made to push it back with a metal catheter into the bladder. The catheter should have an opening at the end, and a little fluid may be injected through this to dilate the urethra around the stone and facilitate its passage backwards. In some cases it is found impossible to move the stone, and then it must be cut down upon in situ, the urethra opened and the stone removed. This should never be done in the penile portion of the urethra if it can be avoided, as it is very likely to be followed by the formation of a urinary fistula. In boys, impaction of a stone in the urethra is the most common cause of retention. It is most frequently situated in the fossa navicularis, and then can be at once felt by the introduction of a probe. It is usually easily removed, in these cases, by the introduction of the bent end of a hair pin down the urethra beyond the stone and then prising it out. When situated farther back it should be pushed into the membranous portion of the urethra, cut down upon in the perineum and removed; or, if the surgeon is provided with the necessary instruments for lithotrity, it may be pushed backwards into the bladder and crushed.

Urethral fistula.—Three forms of urethral fistula may be described: (1) penile; (2) perineal or scrotal; (3) rectal.

1. **Urethro-penile fistula.**—This is not common, and when it occurs is either the result of a lacunar abscess following gonorrhœa, or from the destructive ulceration of a soft chancre, or an epithelioma, which spreads inwards and opens up the urethra. When produced by a lacunar abscess it is usually short and direct. During micturition a few drops of urine escape from the opening, which prevent its closing. These fistulæ are very difficult to heal. Sometimes the application of the actual cautery will succeed in closing them, but the best mode of treatment is to freshen the edges and bring them together with sutures. After the operation a catheter must be passed and tied in the bladder. To the end of the catheter a piece of tubing must be attached and carried into a receptacle under the bed, so as, by a syphon action, to keep the bladder constantly drained. If the

catheter is simply plugged, and the patient allowed to pass water at stated intervals, some of the urine is sure to find its way by the side of the catheter, and the operation will probably fail.

2. **Urethro-perineal** or **urethro-scrotal fistulæ** are most commonly the result of stricture and urinary abscess, but may also arise from several other causes, as prostatic abscesses opening externally; peri-urethral abscesses, or abscess of Cowper's glands; and in some cases of tuberculous or malignant disease of the urethra. When arising from stricture, they may be multiple, and may open in the perineum, scrotum, buttock or groin. They must not be mistaken for fistula in ano, or for a sinus connected with diseased bone, but the history of a stricture and the leakage of urine during micturition is usually sufficient to establish a diagnosis. The treatment has already been discussed (page 1006).

3. **Urethro-rectal fistula.**—The principal cause of this form of fistula is abscess of the prostate, which may burst both into the rectum and urethra; but they are also occasionally the result of wound of the rectum in the lateral operation of lithotomy. In these cases the urine usually finds its way into the rectum, and it is rare for the fæces to pass into the urethra. The treatment is not satisfactory. Occasionally they may be induced to heal by confining the patient to bed and draining the bladder by a syphon catheter, so as to keep the urethra dry, and at the same time washing the rectum out daily with a weak boric acid solution. Plastic operations, undertaken with a view of closing the opening from the rectum, rarely succeed.

Tumours of the urethra.—Tumours of the urethra in the male are uncommon, and, with the exception of the vascular caruncle, are not often met with in either sex.

Vascular caruncles, partaking of the nature of a papilloma, are frequently met with growing from the orifice of the urethra of the female, and occasionally in the male. They are small, pedunculated or sessile tumours, of a bright red colour, which may sometimes be seen protruding from or partially surrounding the orifice of the urethra. They consist of a vascular connective tissue, covered with stratified epithelium, and usually papillated on their surface. Like other papillomata, they are prone to bleed, and in the female are often very sensitive, causing great pain in micturition and during connection. The treatment consists in snipping off the growth with scissors, and destroying the base with the actual cautery.

Polypi.—Small polypi are occasionally found in the urethra. These may be either little polypoid masses of granulation tissue arising in cases of gleet, or may partake more of the character of the myxomatous tumour. They may grow from any part of the urethra, but are generally situated near the orifice, when they may become prolapsed during micturition. They sometimes bleed and may cause obstruction to the passage of the urine. If suspected, their presence may be ascertained by the endoscope, or if near the orifice by simply separating the lips of the urethra. They may be treated by the application of nitrate of silver.

Cancer.—Primary carcinoma of the urethra is very rare. It usually occurs in men over fifty who are the subjects of stricture. It is characterised by pain, increasing difficulty in micturition, and the formation of a hard tumour in the course of the urethra. Its diagnosis in the early stage is difficult, and later on treatment by removal is hopeless, as it usually affects the deeper parts of the urethra. The treatment is merely palliative.

CHAPTER XVI

INJURIES AND DISEASES OF THE MALE GENERATIVE ORGANS

INJURIES AND DISEASES OF THE SCROTUM

Contusions of the scrotum are common, and on account of the large amount of loose connective tissue the extravasation of blood rapidly spreads through it, and the scrotum may become swollen to the size of a fœtal head or even larger and be perfectly black. Still, these injuries are rarely followed by any serious consequences. They may be complicated with effusion of blood into the tunica vaginalis constituting hæmatocele, which will be considered later; or by rupture of the urethra, with extravasation of urine and consequent sloughing.

The **treatment** consists in supporting the testicles in a scrotal sling and applying cold evaporating lotions.

Wounds of the scrotum are often extensively lacerated. Sometimes the whole scrotum may be torn off, and the testicles hang exposed or be implicated in the injury. In consequence of the retraction of the dartos in wounds of the scrotum implicating the tunica vaginalis, the testicles may be prolapsed. They must be replaced in their natural cavity, and the wound sutured. Wounds of the scrotum are prone to rapid union. They must be treated on ordinary principles.

The scrotum is sometimes cleft in cases of hypospadias (see page 990).

Eczema of the scrotum is a common condition, where there is dribbling of urine from any cause, and has a tendency to spread to neighbouring parts and cause great pain and discomfort to the patient. It must be treated by removal of the cause.

Parasites.—Pediculi pubis invade the scrotum, and are caused by direct contagion. They cause great itching, and can be seen by the naked eye. The treatment consists in applying some form of mercurial, of which a solution of corrosive sublimate of the strength of 1 in 500 is the best.

Œdema of the scrotum occurs as secondary to disease of some other organ, as in cardiac, renal, or hepatic dropsy; but in addition to this a primary inflammatory œdema is liable to be set up from some local irritation as a crack or fissure in the skin, and is of importance as it is attended with great swelling, and is likely to end in rapid sloughing.

The **treatment** consists in making free incisions to let out the effused fluid, applying hot fomentations, and elevating the parts by means of a scrotal sling.

Elephantiasis of the scrotum (*Lymph scrotum*) has already been described (page 383).

Non-malignant tumours of the scrotum.—Nævus is the most common form of innocent tumour of the scrotum, and is not infrequently seen in young children. It is to be treated on the same lines as nævus in other parts of the body. Other innocent tumours are the fibromata and the lipomata, but they are rarer than the angiomata. The fibromata may sometimes attain a very large size. These tumours should always be removed if possible.

Malignant disease of the scrotum is usually epithelioma; but melanotic sarcoma occasionally occurs in this situation.

Epithelioma of the scrotum.—This is usually known by the name of *chimney sweep's cancer* on account of its prevalence among chimney sweeps from the irritation produced by the lodgment of soot in the rugæ of the scrotum. That the irritation of soot is capable of producing epithelioma is confirmed by the occasional occurrence of epithelioma about the hands of gardeners who use soot as a dressing for their plants. Epithelioma scroti may occur from the irritation produced by other irritants than soot; it is not unknown in men who work in gas and tar works. It is slow in its growth, only tardily implicating the lymphatics and spreading slowly. It is also not very prone to return, if removed thoroughly. It may be regarded, therefore, as one of the least malignant of the squamous epitheliomata.

It usually begins as a small wart or tubercle, in men beyond the middle period of life. This may remain apparently an innocent growth for some time, and then slowly break down and ulcerate. It forms a sore which may spread in one direction and become covered with a scab in another, and which discharges a thin ichorous fluid (fig. 387). It may at last involve a considerable part of the scrotum, and may sometimes extend deeply and invade the testicle. Later on the inguinal glands become implicated, and it sometimes happens that these glands are enlarged, and the seat of carcinoma germs after the excision of a primary epithelioma, where there has been no local recurrence. Butlin states that these glands may become carcinomatous in chimney sweeps, where there has been no evidence of primary disease in the scrotum.

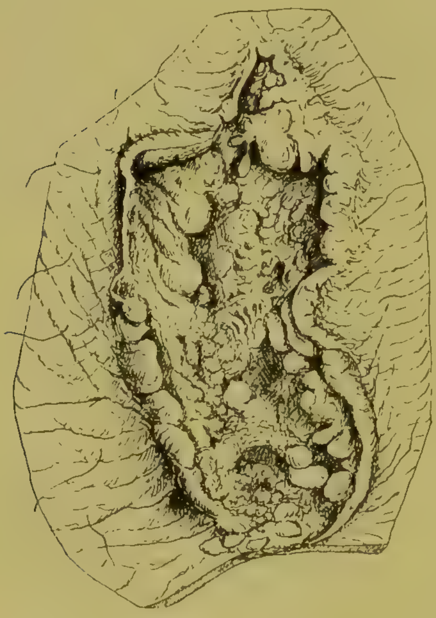

FIG. 387.—Epithelioma of the scrotum from a chimney sweep. (From the Museum of St. George's Hospital.)

Treatment.—Free and early excision is the rule in these cases, and if the inguinal glands have not become implicated and the disease is thoroughly removed, there is a very fair prospect that no recurrence will take place. If the glands are involved, they also should be removed, but the prospect of non-recurrence is not then so hopeful.

INJURIES AND DISEASES OF THE PENIS

Congenital defects.—There may be an entire absence of the penis, the urethra opening into the rectum or just outside the anus; or the corpora cavernosa may be absent or only very slightly developed, the penis consisting simply of the tube of the urethra covered by skin; or, on the other hand, in rare instances there may be a double penis, from both of which urine and semen may be discharged.

Sometimes the penis may be adherent to the scrotum, the skin on the under surface of the penis being directly continuous with the raphé on the front of the scrotum. In these cases when erection takes place the penis is arched into a bow, and the patient is incapable of having connection. This condition is very often associated with hypospadias (page 990).

Wounds of the penis are always serious if they are of any depth so as to penetrate the corpora cavernosa or the corpus spongiosum. If one of the former bodies is wounded, the resulting cicatrix contracts and produces a permanent distortion of the penis, which is very marked when the penis is erect, bending it over to one side and preventing copulation. When the corpus spongiosum is wounded the urethra is generally also injured, and this leads to difficulty in micturition, and a subsequent stricture or a urinary fistula may result. In these cases adaptation of the edges of the wound by suture with careful antiseptic treatment should be carried out. If the urethra is opened, the margins of the opening should be carefully approximated, and a full-sized catheter passed and retained in the bladder.

The fibrous stroma of the corpora cavernosa may be torn, generally through some forcible bending of the organ when it is erect; this is followed by similar results as occur after wounds of these bodies. Union takes place by cicatricial tissue, which subsequently contracts and produces permanent incurvation of the organ, and when erection takes place the portion of the penis which has been involved in the injury remains flaccid, because the cavernous spaces of the tissue are consolidated by inflammatory exudation. A peculiar accident has been recorded in which the penis has been stripped from its coverings and displaced into the scrotal tissues or on to the abdominal wall, the skin of the penis and the prepuce remaining in their normal position. In a case of this kind, under the care of Sir W. Fergusson, the penis was displaced into the right groin, and the patient, a boy aged fourteen, passed his urine through a fistulous opening in this situation.

Phimosis.—This is a term used to imply an inability to retract the prepuce. It may be either congenital or acquired.

Congenital phimosis.—At birth the internal surface of the prepuce is usually adherent to the glans, but the adhesions disappear after a time. If, however, the orifice of the prepuce is too small, they persist. The secretion of the glands around the corona is thus unable to escape, and collects as a white cheesy material in the sulcus behind the corona glandis. This sets up irritation and inflammation from decomposition, and causes a train of symptoms which to a certain extent resemble stone in the bladder. There is frequent micturition, pain and difficulty in passing water, sometimes with retention, at others with incontinence, and the child is constantly noticed to be pulling the foreskin. This condition may sometimes lead to hypertrophy and fasciculation of the bladder walls, and to dilatation of the ureters and pelves of the kidneys. The constant straining may give rise to hernia and prolapsus; and various nervous conditions, such as spastic paralysis of the lower limbs, convulsions, and even epilepsy, are said to be caused by it. Later on in life the constant irritation produced by the retained secretion may be a potent cause in the production of epithelioma of the penis. In some children the orifice of the prepuce may be reduced to the size of a pin point; when this is the case, the urine escapes from the urethra and distends the cavity of the prepuce, the adhesions between this covering and the glans penis being broken down. The end of the penis becomes swollen up like a balloon at each act of micturition, and gradually subsides as the urine escapes through the small opening. Sometimes the prepuce is unnaturally long, without the orifice being unduly contracted; this is more a condition of local inconvenience and annoyance than anything else, and requires careful attention to cleanliness and to the removal of the sebaceous secretion from the Tysonian glands.

Acquired phimosis.—Men in whom the prepuce is naturally tight or in whom it is preternaturally long are very liable to get phimosis from repeated attacks of balanitis, which may be set up by gonorrhœa, chancre, or in gouty or diabetic subjects. It may also occur from superficial ulcerations, which are not uncommon in elderly men or from repeated attacks of herpes. These inflammatory conditions cause thickening and subsequently contraction of the prepuce, and the patient finds at last that he is unable to retract it over the glans.

Treatment.—Congenital phimosis should always be treated by circumcision, and most cases of acquired phimosis are best treated in the same way, though some few may possibly be relieved by dilatation.

Circumcision.—The operation of circumcision is easily performed, but requires a certain amount of care and judgment to remove sufficient, and not too much, of the foreskin. If too little is removed, the line of incision will contract, and the patient be in as bad a condition as before; if, on the other hand, too much is removed, the penis may become twisted or bent by the subsequent contraction of the cicatrix. The operation is performed as follows: the prepuce is drawn forwards and grasped by a clamp or pair of polypus forceps placed just in front of the glans. The portion of prepuce in front of the clamp is now removed by inclining the knife downwards and forwards, so as to avoid cutting the frænum. When the clamp is removed, it will be seen that a belt of skin has been taken off and that the mucous surface of the prepuce still covers the glans. One blade of a pair of scissors is now introduced into the preputial orifice and pushed down to the corona, and the mucous surface of the prepuce divided on the dorsum of the glans down to the point of its attachment to the body of the penis. If any adhesions exist between the prepuce and glans, they are to be separated, and smegma, if present, removed. The whole of the mucous surface is to be cut away, except about half an inch at its attachment at the base of the glans penis. All bleeding points are to be twisted or tied, and the edges of the skin and mucous membrane are to be accurately adjusted and sutured with fine catgut sutures. Some surgeons do not use any sutures, others only use one or two to keep the parts in apposition; but if the two cut surfaces are accurately sutured, primary union may be confidently expected in a few days. When catgut sutures are used, they become absorbed, and there is no necessity to remove them, a proceeding which it is as well to avoid if possible. The best dressing is to encircle the line of union with a narrow strip of gauze, and then paint it over with Whitehead's varnish.[1] This dries in a few minutes and forms a firm dry dressing, under which the wound heals rapidly. Care must be taken not to occlude the urethral orifice, so that the child can pass his water without disturbing the dressing. This may be left on till the fourth or fifth day, when it will probably have become loose, and can be removed by inserting the blade of a pair of scissors under it and slitting it up.

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[1] Whitehead's varnish consists of the ordinary ingredients of friar's balsam, with the substitution of a saturated solution of iodoform in ether for the rectified spirit.

Paraphimosis is the strangulation of the glans penis by a prepuce which has been forcibly drawn back and cannot be replaced. It occurs in individuals who have naturally a tight foreskin, and this being withdrawn causes compression of the vessels supplying the glans, and consequent congestion and swelling, which prevents it being replaced in its normal position. Great œdema of the prepuce results, and if not relieved the constriction may be so great as to cause ulceration or even sloughing.

The **treatment** consists in seizing the penis between the fore and middle finger of each hand, pressing the blood out of the glans with the thumbs, and then dragging the foreskin forwards by means of the fingers, at the same time that the glans is pushed backwards by the thumbs. If this fails, the constricting band—that is, the free border of the prepuce—must be divided, when reduction can be effected.

Preputial calculi.—In cases of phimosis the collections of smegma may become impregnated with lime salts and form concretions, which may remain lodged under the foreskin. They are usually soft and composed of epithelium, lime salts, and cholesterine. In a case mentioned by South there were over two hundred of these small calculi ; and among the natives of the Solomon Islands, where congenital phimosis is almost universal, the condition is not uncommon.

Balanitis and **posthitis.**—By the term *balanitis* is meant an inflammation of the glans penis ; and by *posthitis*, an inflammation of the mucous surface of the prepuce. The two conditions generally co-exist, and the name *balano-posthitis* is then given to it. It arises in its acute form from gonorrhœa and non-infecting sores, and in a more chronic form from the accumulation of smegma under a tight foreskin. It also occurs in the gouty, caused by over-acidity of the urine. The prepuce becomes swollen, red, and infiltrated ; the glans and inner surface of the prepuce red, glazed, and superficially excoriated. There is a sensation of smarting or burning, and pain on passing water. There is a purulent or muco-purulent discharge, and the glands in the groin often become enlarged and suppurate.

Treatment.—In the simpler cases the constant syringing of the parts with a weak boracic solution, with regulation of the bowels and attention to the diet, may effect a cure ; but in severe cases, or after repeated attacks, circumcision should be performed, especially as the disease, in elderly men at all events, may terminate in epithelioma. After circumcision attention to cleanliness will seldom fail to cure the condition.

Chronic inflammation of the corpora cavernosa.—This is a condition which is probably due to a gouty state, though the cause and pathology of the disease is not clearly understood. Pain is complained of in the penis, and when an erection takes place the pain is very considerable ; the erection is imperfect, and the penis very often bent to one side. Upon examination of the organ, one or more hard nodules can be felt in the substance of the corpora cavernosa, which are tender on pressure. The disease is believed to partake of the character of gouty phlebitis, and the nodules to be due to thrombosis of the venous spaces of the erectile tissue. The treatment consists in combating the gouty condition, and in applying lead lotion and later on mercurial ointment to the penis.

Herpes is a common affection of the penis, and attacks both the prepuce and the glans. It is especially prone to occur in gouty subjects, and some individuals are particularly liable to be affected. It begins with intense itching, and in the course of a few hours a number of papules appear on an erythematous patch; these soon become vesicles and then pustules, which leave minute ulcers. They heal in the course of a week from the commencement of the attack.

Treatment.—In the majority of cases all that is necessary is to administer a purge and keep the parts dusted with a powder consisting of equal parts of oxide of zinc and starch; but if the patient is gouty and has had repeated attacks, the constitutional condition must be treated and the diet carefully regulated.

Papillomata.—Warts on the penis are not uncommon, and may be produced by the irritation of dirt, retained secretions, or discharges; or they may be syphilitic. They usually arise from the furrow behind the corona, but may also grow from the inner surface of the prepuce and the glans. They may be very numerous, so that the end of the penis may be entirely obscured by them, and present the appearance of a red, vascular, nodulated mass, which secretes a foul discharge (fig. 388).

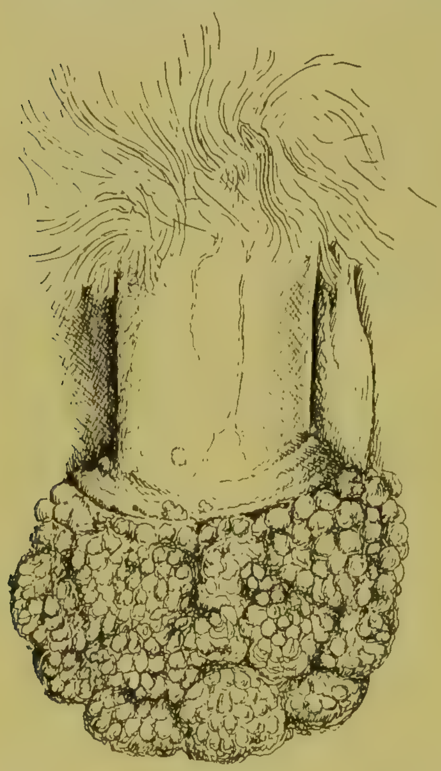

Fig. 388.—Papillomata of the penis. (From the Museum of St. George's Hospital.)

The **treatment** consists in removing them with scissors, and touching the rawed surfaces with solution of chloride of zinc, or glacial acetic acid. In the early stage, where only one or two warts exist, they may be destroyed with the acid nitrate of mercury, but care must be taken to thoroughly eradicate them, as they will speedily return and spread if any portion of the growth is left behind.

Malignant disease of the penis is almost always of the squamous epithelial type, though some few cases of sarcoma have been recorded. Like squamous epithelioma elsewhere, the great cause of the disease is long-continued irritation. Thus in a large majority of cases it occurs in individuals who are the subject of phimosis, and in whom the secretion of the glands around the corona is retained and becomes a source of irritation; but gouty balanitis, the presence of a urinary fistula, warts, or any chronic irritation, may be an important factor in the production of the disease. Cancer of the penis is not a very common disease in comparison with carcinoma of many other organs. It usually occurs in late middle life or old age, and begins either as a papule or wart, which usually springs from the sulcus behind the glans. When it begins as a papule or tubercle, it appears first as a hard, reddish mass, which speedily ulcerates and discharges a fœtid sanious fluid. In those cases where there is phimosis, this cannot be seen, and the earliest symptoms are swelling about the end of the penis, followed by a foul discharge, which later on becomes blood-stained. Upon examination a hard and often apparently localised mass can be felt through the skin in the situation of the corona. Finally the growth invades the skin, which gives way and the tumour fungates. If in the early stages the foreskin can be retracted or is slit up, an ulcer surrounded by hard and indurated everted edges and sloughy surface will be seen, which bleeds readily and discharges a foul sero-purulent fluid (fig. 389). When the disease begins as a wart the conditions can scarcely be distinguished from an ordinary papilloma until the base becomes hard and the warty growth ulcerates, when it presents very much the same character as the nodular form. The glands in the groin are usually affected early. The special point in the diagnosis of cancer of the penis is to distinguish it from syphilitic ulceration, and this can generally be done by watching the effects of treatment; a sore on the penis in an elderly man which resists specific treatment and strict cleanliness for a fortnight ought always to be regarded with the very gravest suspicion. In a doubtful case, the removal of a small portion of the growth under cocaine, and its microscopic examination, will settle the question.

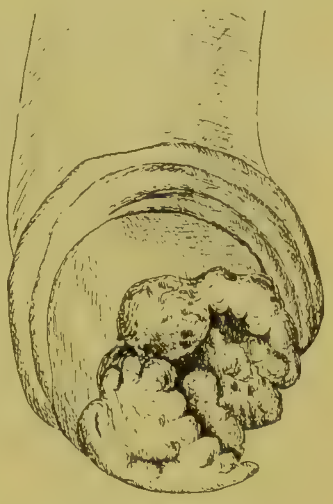

Fig. 389.—Cancer of the penis. (From the Museum of St. George's Hospital.)

Treatment.—When the diagnosis of cancer is clear, the penis must be amputated well behind the point to which the disease has extended; the amount, therefore, of penis which will require removal depends on the extent of the disease. In the majority of cases amputation just in front of the pubes is all that is required, but in some severe cases the whole of the penis, including its crura, requires removal.

Amputation of the penis in front of the pubes. The parts having been shaved and properly cleansed, hæmorrhage is restrained by passing a piece of elastic tube round the root of the penis and fixing it with clip forceps. The skin of the penis is then tensed by the left hand of the operator and a circular sweep is made round the organ at the point fixed upon for the amputation, dividing only the skin. In doing this care must be taken not to draw the skin of the penis forwards, otherwise it will be divided at too low a level. The corpora cavernosa are then divided from above, care being taken not to include the corpus spongiosum. These bodies are then separated from the corpus spongiosum forwards for the extent of half an inch, and this latter structure cut through at this level. One blade of a pair of probe-pointed scissors is now introduced into the urethra, and the corpus spongiosum slit up to the level of the section of the cavernous bodies. It is then spread out, so as to form a sort of gutter, and its free margins attached to the skin below by a few sutures. After the operation the stump should be dusted with iodoform and covered with moist gauze. After each act of micturition the parts should be bathed with some weak antiseptic solution. Some surgeons prefer to operate by the flap method. A large rectangular flap is fashioned out of the dorsum of the organ, and is made to cover the front of the stump. The urethra is cut long and is dissected out and brought through a hole in the flap to which it is attached. The objection to this operation is that in order to obtain the flap the operator has to approach too closely to the diseased structures.

Removal of the whole penis.—In those cases where the penis is involved as far back as the scrotum, the whole of it must be removed by separating it from its attachment to the pubic arch. The patient being placed in the lithotomy position, a circular incision is made round the root of the penis, cutting through the skin only. From this incision another is made along the median raphé of the scrotum to the perineum, and the two halves of the scrotum separated from each other by tearing with the fingers. A full-sized bougie is now passed into the bladder, and the membranous portion of the urethra defined and dissected free from surrounding parts as far back as the triangular ligament. The bougie having been withdrawn, the membranous urethra is divided just behind the bulb. The penis is now removed by dividing the suspensory ligament from above, and by separating its two crura from the bone by means of a raspatory. The remains of the urethra is slit up for about half an inch on its dorsal aspect, and the flaps thus formed attached to the skin at the posterior extremity of the incision in the perineum. The rest of the wound is then sutured, drainage being provided for. The patient's mode of micturition is afterwards the same as that of the other sex.

If the inguinal glands are enlarged, they must be removed, if it is believed that they can be thoroughly extirpated; otherwise the operation should not be attempted. Such removal often entails a very serious dissection, which will expose the femoral vessels, the internal saphena vein, and the anterior crural nerve.

Some rarer diseases of the penis require a passing notice.

Persistent priapism.—A few cases of persistent priapism have been recorded. This is a continuous and painful erection of the penis without sexual desire. It appears to usually follow an act of violent coitus or great venereal excess, and has been believed to be due to extravasation of blood into the corpora cavernosa. It is more probably due to some reflex nervous irritation. It is best treated by rest, free purgation and large doses of bromide of potassium.

Gangrene of the penis occurs rarely as one of the sequelæ of typhus, or typhoid fever or smallpox, generally in the aged or those broken down in constitution by privation or drink. It is probably embolic in its origin. It usually terminates fatally either from exhaustion, hæmorrhage or pyæmia. The treatment must be conducted on general principles.

INJURIES AND DISEASES OF THE TESTES

Abnormalities of the testes.—Cases of a supernumerary or third testicle have been described, but, as far as I am aware, no proof exists from actual dissection that such a condition ever exists. Cases in which a body in the scrotum has been believed to be a third testicle are usually encysted hydroceles of the cord which often much resemble the gland. Fibrous bodies sometimes exist in the tunica vaginalis, which may also be mistaken for a third testicle. The opposite condition of absence of one or both testicles is also rare. Most of the cases in which this condition has been believed to exist are where the testicle is retained or atrophied. Instances have been recorded where a part of the testicle has been absent; either the body, the epididymis and vas deferens being present, or the body is present, and the epididymis and vas deferens, in whole or in part, are absent. Or both parts may be developed, but they may not be connected together. It must be borne in mind that these two portions are developed from separate structures in the embryo.

Retained testicle.—The testicle developed in the lumbar region may be arrested or delayed in any part of its transit to the scrotum. It may be retained in the abdomen; or it may be arrested at the internal abdominal ring, or in the inguinal canal; or it may just pass outside the external ring without finding its way to the bottom of the scrotum. Many causes have been assigned for this condition, but it cannot be said that our knowledge on this subject is very exact, though it would appear that in many cases it is due to the absence or abnormal position of one or more of the attachments of the gubernaculum testis, which undoubtedly governs the descent of this body. In other cases it would seem to be due to shortness of the vas deferens or vessels of the cord. Intra-uterine peritonitis has also been regarded as a cause. When the testicle is retained in the abdomen, it gives rise to no symptoms other than the absence of the gland from the scrotum, but when it is retained in the inguinal canal it is subjected to pressure, and may become inflamed and painful, and the inflammation may extend to the peritoneum, producing general peritonitis. It is probable that the testicle when first formed is normal, but it undergoes degenerative changes, and becomes functionally useless, so that a man, in whom both testicles are retained (anorchism) is sterile, though he is not impotent. The absence of one testicle is termed monorchism. When the testicle is retained in the inguinal canal it is often complicated with a congenital hernia, the funicular process of peritoneum not being obliterated.

Malposition of the testis.—The testicle may descend through the inguinal canal, but may miss the scrotum and become misplaced, and assume some abnormal position. This is known as *ectopia* of the testis. There are two principal positions in which the testicle may be found: (1) *Ectopia perinealis* is where the testicle slips down between the scrotum and thigh and becomes located in the perineum. Here it is subjected to great pressure, especially during sitting, and is a source of great pain and discomfort to the patient. In other cases the testicle, upon emerging at the external ring, slips downwards and outwards over the spine of the os pubis, and becomes located over the situation of the saphenous opening. (2) Cases have also been described in which the testicle has been said to find its way out of the abdomen through the femoral ring, and to pass down the crural canal to present at the saphenous opening. And to these the name *ectopia cruralis* has been given, but it is exceedingly doubtful whether such a condition ever exists.

Whether the testicle is retained in the inguinal canal or is ectopic, it is exposed to injury and pressure, and is liable to be attacked by inflammation, or to become atrophied, and later on in life to be the seat of malignant disease. In both retention and malposition the scrotum is not fully developed.

Treatment.—When a testicle is retained or malplaced, unless it is in the abdominal cavity, when it may be safely left alone, the surgeon should consider the feasibility of transplanting it into the scrotum and fixing it there. If this cannot be done, seeing that it is a source of pain and discomfort, that it is functionally useless, and that there is a risk of malignant disease attacking it later on in life, the better plan is to proceed to the removal of the organ.

The operation of transplanting the gland into the scrotum need not be undertaken until the boy is nine or ten years of age. When the testicle is in the inguinal canal, and is complicated with hernia, a radical cure of the hernia is to be performed at the same time, or, under these circumstances, it may be desirable to operate earlier. An incision is made over the inguinal canal, and carried down to the lower part of the scrotum; the tunica vaginalis, which will be found open, is divided above the testicle, and its upper end closed. The testicle is now gently drawn into the scrotum as far as the cord will allow, and the aponeurosis of the external oblique, if it has been divided to expose the testicle, and the pillars of the ring, is then carefully sutured. In order to retain the testicle at the bottom of the scrotum, the little apparatus invented by Watson Cheyne should be used. This consists of a wire cage which fits over the scrotum; a silk suture is attached to the testicle, the two ends are brought out of the bottom of the scrotum, and are tied over one of the bars of the frame. The external wound is then closed. The retaining suture may be removed in ten days.

When the testicle is in the perineum, the most usual form of ectopia, an incision is made from the external ring by the side of the scrotum to the perineum over the testicle, and this body, including its tunica vaginalis, is then freed from surrounding parts as high as the ring. A second incision is made at the bottom of the scrotum, and a bed prepared in this situation for the testicle in the loose connective tissue. A pair of dressing forceps are pushed from this second incision through the scrotum to emerge at the top of the first incision, and by separating the blades a track is formed for the testicle, down which it is gently pushed until it reaches its bed, and it is there fixed by sutures.

The testicle may be malplaced in the scrotum. It may be *inverted*—that is, it may be rotated so that the epididymis is in front. This is important in connection with hydrocele, for under these circumstances the testicle is at the front of the scrotum and the fluid behind, and the unwary surgeon in tapping might introduce his trocar into the body of the testicle instead of into the sac containing the fluid. The testicle may also be *reversed*—that is, the globus major of the epididymis may be at the bottom of the organ, and the vas deferens come off from the top. This is of no clinical importance.

Torsion of the spermatic cord.—In 1885 Nicoladoni drew attention to a case in which the testicle had become strangulated owing to a twisting of the spermatic cord, and since then several cases have been recorded. The condition usually occurs in the young adult, who is the subject of an undescended or partially descended testicle, but it has occurred in the fully descended organ. The exciting cause is unknown. The cord is twisted upon its axis one or more times; the vessels become gorged with blood, and the testis, or the epididymis, or both, become inflamed, and after a time may become gangrenous, or may undergo atrophy.

Symptoms.—In some cases there is a definite history of a sudden muscular effort, followed by pain, and the appearance of a swelling in the groin and scrotum, often accompanied by vomiting, and closely simulating a strangulated hernia. In others, the symptoms set in without any apparent cause. There is a rise of temperature and a quick pulse. The vomiting is not so persistent as in hernia, and there is not absolute constipation. The scrotum soon becomes red and œdematous, and the tunica vaginalis distended with blood.

Treatment.—If the condition is recognised early enough the cord and testis must be exposed, and the cord untwisted. As a rule, however, the condition is not recognised until it is too late to do this, when the testicle must be removed, for if left it will either die or atrophy.

Injuries of the testis and cord.—Contusions of the testicle are not uncommon, and may be caused by blows, kicks, or squeezes, or not unfrequently from a rider striking the pommel of his saddle. They are attended with a very severe, sickening pain, with a considerable amount of shock, which in some cases is so severe as to lead to a fatal issue. The injury may be accompanied by laceration of the coverings of the testicle, and extravasation of blood into the tunica vaginalis (hæmatocele). A contusion of the testicle is often followed by orchitis, and this in its turn may give rise to atrophy, or, on the other hand, atrophy may result from a contusion of the testicle without any intervening inflammation.

The **treatment** consists in keeping the patient on his back, with the testicles well raised by means of a scrotal sling, and applying hot Goulard lotion with opium.

Wounds of the testicle may be either punctured, incised, or lacerated. The punctured wound is the most common, and is sometimes produced by the surgeon inadvertently sticking his trocar into the gland in tapping a hydrocele. It is accompanied by great pain, and may be followed by acute orchitis, but in many cases no serious harm ensues. Incised wounds, if not very deep, usually heal without any untoward symptoms ; but if the instrument which produced the wound is septic, suppuration ensues, and the tubules protruding produce a condition of hernia testis. Lacerated wounds are often produced by gunshot injuries, and are always attended with very severe shock, which may prove fatal. If the gland is quite disorganised it must be removed, otherwise it must be treated on ordinary principles. Sutures are rarely required.

Hypertrophy of the testicle only occurs as a compensatory condition ; where one testicle has been removed, or been destroyed from any cause, or has failed to be developed, the other undergoes compensatory enlargement, and may attain twice its natural size.

Atrophy of the testicle may occur in two different ways. (1) As a result of some inflammatory condition, more especially the orchitis of mumps, but also from other forms of orchitis, as the traumatic or syphilitic, the testicle may undergo a fibroid degeneration ; the connective tissue, which has been infiltrated with inflammatory deposits, contracts, and by its contraction presses upon and obliterates the tubules, so that at last the testicle becomes very small, hard, and nodular, and is composed of nothing but a mass of fibroid tissue, with a few scattered tubes. (2) In other instances the testicle undergoes a fatty degeneration, as the result of defective blood supply. This occurs occasionally after the operation for varicocele, and in cases of nerve lesion. The glandular structure under these circumstances undergoes fatty changes, and becomes soft, small, and flabby. A very similar condition is set up in cases of retained testis, especially if subjected to pressure. The result of atrophy, if both testicles are involved, is sterility, and the development of certain feminine characteristics, such as enlargement of the breasts and a general deposit of subcutaneous fat. This is often accompanied or succeeded by mental depression and melancholia, due, according to the views of Brown Séquard, to a want of re-absorption into the system of the testicular secretion.

Neuralgia of the testicle is an exceedingly intractable and distressing disorder. It is characterised by severe paroxysmal pain in one or both testicles, without any obvious disease of these bodies. It occurs in young men of a neurotic type, and is sometimes accompanied by great mental despondency and melancholia, which often assumes a suicidal form ; or it may occur in elderly men who are of a gouty habit. The pain is not only in the testicle, especially the epididymis, but extends up the cord into the groin, and sometimes up to the loins, and is accompanied by so much tenderness that the patient will shriek out with agony if the testicles are touched, or even from the pressure of the dress. The disease is often associated with varicocele.

The **treatment** consists in attention to the general health. The patient should have change of air, and, if possible, sea bathing ; his diet should be regulated, and the bowels kept freely open. Valerianate of zinc, quinine, or arsenic should be administered internally. Locally belladonna or atropine should be applied, and the patient should keep the testicles supported in a suspensory bandage. If a varicocele exists it should be cured by operation. When it occurs in old men who are gouty the general condition should be treated.

Hydrocele.—By the term *hydrocele* is meant a collection of fluid in connection with the testicle or cord. Here only hydroceles in connection with the testicle will be considered ; those in connection with the cord will be referred to later on.

The forms of hydrocele are numerous, corresponding to the condition of the tunica vaginalis and its funicular process.

1. **Vaginal hydrocele.**—The most common form is the ordinary vaginal hydrocele, consisting in a collection of fluid in the sac of the tunica vaginalis, which is, in its normal condition, separated from the peritoneal cavity by the whole extent of the inguinal canal.

Causes.—The causes of common vaginal hydrocele are very obscure. It is probably due, somehow or other, to an inflammatory condition, though it occurs without any active symptoms of inflammation. In acute orchitis an effusion of fluid into the tunica vaginalis takes place, which is sometimes called acute hydrocele ; this may be absorbed as the inflammation subsides, or it may merge into the chronic type. Again, in chronic inflammations of the testicle, especially when due to syphilis, effusion may take place into the tunica vaginalis, constituting another cause of hydrocele. But, in addition to these two classes of cases, there are a considerable number of instances in which effusion takes place without assignable reason, generally in elderly men, and often in those who have resided in hot climates. It cannot be regarded as a passive effusion or dropsy, as the fluid is different in composition to the ordinary dropsical effusion, containing more albumen and fibrinogen. It is, however, not uncommonly associated with the history of some local injury, which renders the view of its inflammatory origin more probable.

In recent cases the tunica vaginalis remains unaltered, but where the disease is of long standing, especially if the tunic has been irritated, it becomes thickened, roughened on its internal surface, and often covered by a number of small sessile bodies, which are generally fibrous in character, but which may occasionally have small cysts developed in them (fig. 390). The fluid contained in the sac is of a greenish straw colour, of a sp. gr. 1025 to 1030, loaded with albumen, so that it becomes solid on boiling. It often forms a small coagulum on standing owing to the presence of fibrinogen in it, so that if any white corpuscles chance to be present in the fluid, their disintegration sets free the fibrin ferment, and coagulation takes place.

Symptoms.—Vaginal hydrocele presents a smooth pyriform swelling, with its base downwards, on one side of the scrotum. It is elastic to the touch, and usually tense and uniform, but may be soft, and then fluctuation will be detected. It is translucent, except in old hydroceles where the walls of the sac are thick. It is not reducible, has no impulse on coughing, and is dull on percussion. It can be diagnosed: (1) from hernia, by feeling the cord free between the tumour and the external ring, and by its translucency, irreducibility, and absence of impulse on coughing; (2) from hæmatocele, by its translucency, its elasticity in comparison with the solid heavy feel of a hæmatocele, and by the history; (3) from solid tumours of the testicle, by the want, in the latter, of elasticity, uniformity, and translucency, by the pain, and by the rapid enlargement.

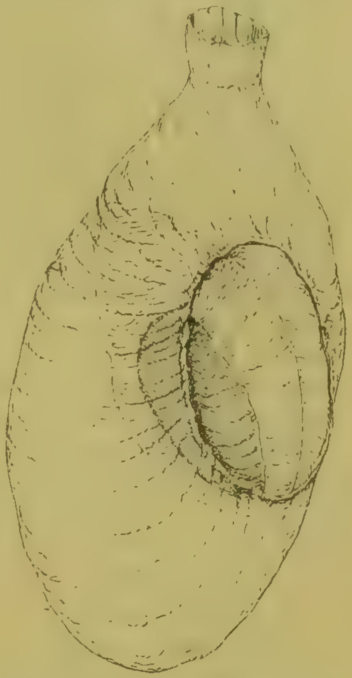

FIG. 390.—Hydrocele of the tunica vaginalis. (From a dried specimen in the Museum of St. George's Hospital.)

Treatment.—The treatment of simple hydrocele in the adult may be palliative or curative. In young children the fluid may be got rid of by the application of stimulating lotions, or, indeed, the hydrocele may spontaneously disappear.

Palliative treatment.—This consists in periodically removing the fluid by tapping. It is an almost painless operation; does not interfere with a patient's occupation, and involves no risk; therefore, some patients prefer to resort to this rather than undergo a radical cure, which certainly confines the patient to bed for some days; may in some cases, at all events, be attended with great pain, and cannot be said to be entirely devoid of risk, especially in elderly men—in whom, therefore, it is often better to advise this plan of treatment. The operation is a very simple one. The position of the testicle is first ascertained, and when it is situated at the lower and back part of the scrotum, its usual position, the hydrocele is seized from behind, and the skin over the front of the tumour tensed. A point is selected at the lower part of the anterior surface, which is free from veins, and the skin having been purified, a sterilised trocar and cannula are driven into the sac in a direction almost directly upwards, and the fluid is allowed to escape. When the sac is quite emptied the cannula is withdrawn, and the little puncture sealed with a piece of gauze and collodion. A suspensory bandage is adjusted, and the patient may at once be allowed to go about. After a time the sac will refill, and the operation will require to be repeated, usually in about four to six months, or it may be longer.

Radical treatment.—Many different plans have been suggested for the radical cure of hydrocele. The principal of these are: (1) injection; (2) incision; and (3) partial excision of the sac.

(1) **Injection.**—This plan of treatment consists in tapping the hydrocele, and, after the fluid has been withdrawn, injecting some stimulating fluid, which will excite a certain amount of inflammation in the sac and will

cause the two surfaces to adhere together, either partially or completely, or will so alter the serous membrane as to destroy its power of secretion. Many different fluids have been recommended, but the two most commonly employed are tincture of iodine and carbolic acid dissolved in glycerine. Of the two, I give preference to the tincture of iodine, as the more certain. Carbolic acid was recommended because it was said to cause less pain, but in some cases in which I have used it the pain afterwards has been very intense. In using the tincture of iodine, the old Edinburgh tincture, which is twice as strong as that of the British Pharmacopœia, should always be employed. The amount injected must vary according to the size of the sac, but in most cases a couple of drachms will be found to be sufficient, unless the sac is very large. All the fluid must be drawn off before the injection is made, and the whole of the tincture may be allowed to remain in the sac. When carbolic acid is used it should be dissolved in 5 per cent. of glycerine, and from half a drachm to a drachm injected. These injections are followed by very severe pain for some few hours, often requiring a subcutaneous injection of morphia to relieve it, and considerable swelling of the scrotum, which after a few days subsides, and a cure may be anticipated in a very considerable percentage of cases, if there is no morbid condition of the testicle itself. But in a certain number of cases failure occurs, and these are generally cases in which the sac is much thickened, or sessile bodies are attached to its internal surface.

(2) **Incision.**—Incision should be resorted to where the sac is very thick, and where injection has failed. The operation consists in making, with antiseptic precautions, an incision, two or three inches long, down the anterior surface of the hydrocele, and laying the sac open for the whole length of the incision. After the fluid has escaped the sac should be washed out with an antiseptic solution, and its internal surface carefully examined to see if any fibrous bodies are attached to it; if so, they must be removed. The sac wall is then sutured to the skin, and the cavity filled with antiseptic gauze, which is withdrawn on the second day and a fresh piece inserted. The wound usually fills up in about three weeks.

(3) **Partial excision of the sac.**—This plan of treatment is usually advocated, as being more certain of cure than the simple incision. I have no personal experience of it, as I have never had a failure from the former plan of treatment. It consists in separating the parietal layer of the tunica vaginalis from its surroundings, and cutting it away close to the testicle. After all hæmorrhage has been arrested a drainage tube is inserted, and the wound closed and dressed in the ordinary way. Recurrence has been said to take place even after this considerable operation.

2. **Congenital hydrocele.**—This and the next two forms of hydrocele to be described depend upon the condition of the tunica vaginalis and its funicular process in respect to their obliteration. In congenital hydrocele the whole of the funicular process remains pervious, and the sac of the tunica vaginalis communicates with the general peritoneal cavity. The communication is generally small; that is to say, it is not large enough to allow of the descent of the gut through it, otherwise a congenital hernia (page 861) would be formed, but it is large enough to allow any fluid in the peritoneal cavity to trickle down and collect in the tunica vaginalis, and thus produce a hydrocele. The condition usually exists in infancy and early childhood, but may be present in adult life. It is distinguished from ordinary vaginal hydrocele by the shape and extent of the swelling, and by

the fact that by steady pressure, or by elevating the scrotum, the sac can be emptied, but this can generally only be done very slowly and with difficulty. It is distinguished from congenital hernia by its translucency, its dullness on percussion, and by the absence of any gurgle upon reduction. The condition is of some importance, since any inflammation excited in the sac might readily spread to the peritoneal cavity. The fluid of a congenital hydrocele is clear and colourless, containing only a trace of albumen.

Treatment.—The treatment consists in attempting to cause obliteration of the funicular process by pressure. A truss should be applied so that the pad presses on the inguinal canal and the external abdominal ring. This will usually cause obliteration, and when this is done the fluid in the sac may disappear of itself, or may be got rid of by the application of chloride of ammonia or other stimulating lotion. Should this fail, the sac should be laid open, its neck ligatured, and the sac wall attached to the skin and dressed in with gauze.

3. **Infantile hydrocele.**—This form of hydrocele differs from the congenital in the fact that the funicular process has become shut off from the peritoneal cavity above, but remains pervious throughout the rest of its extent. It will be remembered that in the process of development after the testicle has reached the scrotum, obliteration of the funicular process commences above and below—that is, at its two extremities—and gradually spreads upwards and downwards until the whole is obliterated. In infantile hydrocele the obliteration takes place above, but not below, and may spread as far as the external ring, the rest of the process remaining pervious. It resembles the vaginal hydrocele in the fact that its fluid is derived from the vaginal sac, but differs from it in its shape, the collection of fluid extending up the cord and sometimes into the inguinal canal, when the obliteration downwards of the funicular process has not proceeded far. It is distinguished from congenital hydrocele by the fact that it does not diminish on pressure or on elevation of the scrotum.

Treatment.—It can generally be cured in childhood by the application of the chloride of ammonia lotion. If not, it should be tapped and the lotion again applied. In the adult, incision as in ordinary hydrocele will succeed in effecting a cure.

4. **Hydrocele of the funicular process.**—This is a very rare form of hydrocele, and is due to closure of the funicular process at its lower end, and its non-obliteration throughout the rest of its extent. This portion becomes distended with fluid which trickles down from the peritoneal cavity. It forms a sausage-shaped tumour, which distends the inguinal canal and upper part of the scrotum, and below it the testicle can be felt, free and unsurrounded by the swelling. The tumour is translucent, and can be made to disappear by steady, continuous pressure. It is distinguished from a hernia of the funicular process (page 885) by its translucency, its dullness on percussion, and by the manner of its reduction, slowly and without gurgle. It can generally be cured by reducing the swelling and applying a truss, which will cause obliteration of the process.

5. **Encysted hydrocele.**—This variety of hydrocele differs from those previously described, inasmuch as it is a new formation and not the collection of fluid in a pre-existing space. It occurs under two forms: (*a*) spermatocele or spermatic cyst; (*b*) cyst of the body of the testicle.

a. **Spermatocele** or **encysted hydrocele of the epididymis** (fig. 391) is the more common and important condition, and is usually found in connection with the globus major of the epididymis, growing out from among the vasa efferentia. The cyst is usually single, and rarely attains a larger size than a walnut. It consists of a thin wall of connective tissue, often with some muscular fibre, and lined by columnar cells. Its contents consist of a limpid opalescent or milky fluid, containing only a small quantity of albumen, and being of a lower specific gravity than ordinary hydrocele fluid. Upon microscopic examination it is found to contain spermatozoa, and the opalescence of the fluid is no doubt due to the presence of these bodies. Many causes have been assigned as the origin of these cysts. They have been regarded as due to (*a*) dilatation of the seminal tubes; (*b*) rupture of one or more seminal tubes, and the formation of an adventitious cyst; (*c*) a primary cystic formation in the connective tissue, and the subsequent rupture into it of a seminal tube; (*d*) embryonic remains undergoing cystic formation in after life. Of these, the ducts of Kobelt, remnants of the tubes of the Wolffian body, are the most probable source; but the hydatid of Morgagni, the organ of Giraldes, and the vas aberrans of Haller have all been stated to be the seat of this cystic formation.

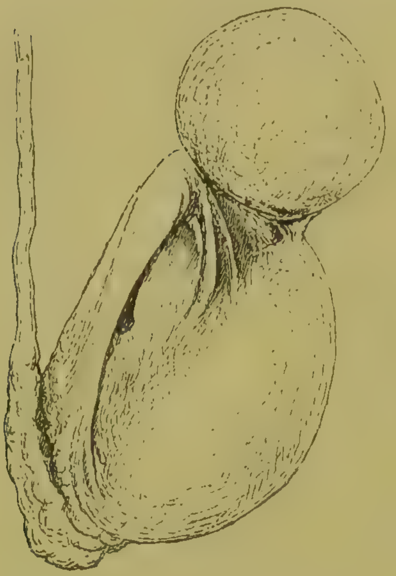

FIG. 391.—Encysted hydrocele. (From the Museum of St. George's Hospital.)

Symptoms.—The symptoms consist in a slowly growing, painless swelling, which is tense and elastic in consistency; does not envelop the testicle; and is situated below and in front of the swelling. It is usually smooth and globular in outline, and the sac wall is thin and the tumour translucent. It has been mistaken for a supernumerary testicle, which it sometimes resembles, but it has no testicular sensation, and the translucency can generally be made out.

The **treatment** consists in the first instance in tapping the hydrocele and drawing off the fluid, and very often this is all that is necessary. If this fail, incision or even excision may be practised, for these cysts can usually be isolated without difficulty. As a rule, the disease occasions so little discomfort that patients are unwilling to submit to these operations, and the necessary confinement which they entail; nor, indeed, is it necessary to insist upon their performance.

b. **Encysted hydrocele of the body of the testicle.**—This is a condition of absolutely no importance. It is merely a little serous cyst, formed in the connective tissue between the tunica albuginea and the tunica vaginalis, generally on the anterior surface of the testicle. It rarely attains any size, gives rise to no inconvenience, and as a rule requires no treatment.

6. **Hydrocele of a hernial sac.**—Another form of collection of fluid in the neighbourhood of the testicle is a hydrocele of a hernial sac, where an inguinal hernia has previously existed, but has been cured by its communication with the peritoneal cavity having been closed, but where the sac of the hernia still remains, in which fluid collects. The fluid con-

tained in the sac is very much the same as in a vaginal hydrocele. It is a very rare condition.

Symptoms.—The swelling is elastic, often fluctuates, and is translucent. It obscures the cord and often extends up the inguinal canal, and in this respect simulates a hernia, but there is no impulse on coughing. It is quite distinct from the testicle, which can be clearly differentiated from it, and this serves to distinguish it from vaginal hydrocele. There is generally the history of a hernia, and that the patient has been in the habit of wearing a truss.

Treatment.—It should be tapped, and if it refills the sac should be dissected out. Injections should not be used in these cases, for fear that the communication with the peritoneal cavity is not completely shut off.

Another variety has been described, where a cavity is formed out of a portion of a hernial sac which has become shut off from the rest by adhesions forming between a piece of irreducible omentum and the wall of the sac (see page 862).

Hæmatocele.—By the term *hæmatocele* is usually meant a collection of blood in the cavity of the tunica vaginalis, but it is also applied to collections of blood in an encysted hydrocele or in a hydrocele of the cord, which in consequence of some blow or injury has become filled with blood. Hæmatocele is also sometimes used to denote extravasations of blood into the scrotal tissues outside the tunica vaginalis ; a condition which frequently exists in connection with effusion into the sac, the result of blows or squeezes.

Causes.—The most common cause of hæmatocele is the rupture of the weakened capillaries in the wall of the sac of a hydrocele, when it has been tapped and the support of the vessels taken away. It may also arise from puncturing the testicle in tapping for hydrocele ; or it may be caused by a blow, kick, or squeeze, when it is generally associated with extravasation of blood into the loose connective tissue of the scrotum.

Pathological changes.—The blood within the sac, in cases where the effusion is great, becomes partially coagulated, and fibrin is deposited on the interior of the sac, forming a shaggy layer or layers of a fibrinous character. The sac wall becomes thickened and condensed and sometimes calcified, and the tissues outside the sac matted together. The testicle is compressed, atrophied, and sometimes is scarcely to be recognised. In the interior of this thickened cavity is a collection of fluid, consisting of altered blood; sometimes thick and dark and resembling treacle ; at other times a dirty brownish fluid, like fæces. Upon microscopic examination all traces of corpuscles will be found to have disappeared from it, and nothing will be discovered but shreds of fibrin and crystals of cholesterine. In slight cases, where the effusion is not great, absorption may take place without these changes occurring.

Symptoms.—The symptoms are characterised by the rapid formation of a scrotal swelling, which is at first smooth and uniform and of a pyriform shape, resembling a hydrocele without its translucency. Soon, however, it becomes hard, firm and heavy, resembling a solid tumour. It is frequently associated with bruising of the tissues of the scrotum, the skin of which is discoloured.

Inflammation going on to suppuration, as a result of auto-infection, may follow ; the swelling then becomes hot and tender. There is fever, and possibly a rigor and much throbbing pain.

The **diagnosis** has to be made from hernia, hydrocele, and solid growths of the testicle. From *hernia* the diagnosis is made by the possibility of isolating the cord above, by the absence of impulse, by its non-resonance and irreducibility. From *hydrocele*, by its being heavier and feeling more solid; by its non-translucency, and by the suddenness of its onset. From *solid growths* there is often the greatest difficulty in forming an opinion, and in many it is only by an exploratory puncture or incision that an accurate diagnosis can be arrived at. The history of the case and the rate of increase of the growth, the sudden appearance of the hæmatocele, and then the stationary condition of the growth as contrasted with the steady and uniform increase of a malignant tumour, are points to be weighed in making a diagnosis. In malignant disease the cord is also generally implicated; whereas in hæmatocele, if it is isolated above the tumour it will be found to be normal.

Treatment.—When the patient is seen immediately after the injury, he should be placed in bed on his back; the testicles well supported in a sling, and evaporating lotions applied. If in the course of a day or two there is no diminution of the swelling, aseptic tapping should be resorted to. The withdrawal of even a small quantity of the fluid will sometimes start the process of absorption, and the rest of the swelling will disappear. Assistance may be occasionally rendered by making pressure by means of strapping. In old cases where the hæmatocele is of some standing, a free aseptic incision should be made into the sac, its contents cleared out, and the walls well rubbed with carbolic solution and the cavity packed with gauze.

Inflammation of the testicle may be divided into an acute and chronic form. Inflammation may primarily affect the body of the testicle, when it is termed *orchitis*, or it may primarily commence in the epididymis, when it is known as *epididymitis*, and these two conditions arise from different causes, and the inflammation may remain limited to the one or the other, though in the majority of cases the part which is not primarily involved becomes secondarily affected.

Acute orchitis, or inflammation of the body of the testicle, may result from injury, or it may occur as a sequel to certain infective conditions, of which mumps is the most common; but typhoid fever, influenza, and smallpox may also be mentioned as examples; or it may occur as a primary condition in gouty, and less frequently rheumatic, individuals.

Acute epididymitis is almost always caused by some affection of the membranous or prostatic portion of the urethra, and is due to a direct extension of the inflammation from the urethra along the vas deferens to the epididymis, though other theories, such as metastasis, sympathy, and reflex congestion, have been at various times brought forward to explain this condition. The most common affection of the urethra which gives rise to epididymitis is gonorrhœa, but the lodgment of a calculus in the urethra, catheterism, gouty urethritis, stricture of the urethra, and inflammatory conditions of the prostate may all give rise to it.

Symptoms.—In very acute cases the disease may be ushered in by a rigor, accompanied by intense sickening pain in the testicle, extending to the loins. In less acute cases there is an uncomfortable aching pain at first in the testicle, culminating in the course of a few hours in severe sickening pain. The testicle becomes swollen. In epididymitis the swelling first appears in the globus minor, and then extends to the body and globus major; so that the epididymis can be felt as a crescentic swelling on the outer and back part of the testicle. It is acutely tender and hard, and the cord is frequently swollen and infiltrated. When the body of the testicle is the part primarily involved, it becomes more or less globular and swollen. The scrotum is red, tense, and glistening, and there is very often considerable effusion into the sac of the tunica vaginalis, constituting what is called *acute hydrocele*. Attending these local signs there is usually a considerable amount of constitutional disturbance; the temperature is raised above normal, there is a feeling of nausea, the appetite is lost, the tongue foul, and the bowels constipated.

The inflammation occasionally runs on to suppuration, but this sequel is not common. When it occurs, and the abscess is allowed to burst, hernia testis may follow. A more common sequel of the condition is atrophy and a spoiled testicle. This is due to the tubuli seminiferi and ducts of the epididymis being constricted by the inflammatory material, which becomes organised into fibroid tissue. In this way, if both testicles are affected, the patient may become sterile.

Treatment.—The treatment of acute inflammation of the testicle, whether affecting the body or epididymis, is fairly simple. The patient is confined to bed, with his testicles well slung up and elevated by a scrotal sling, and hot Goulard lotion and laudanum applied. A dose of calomel, followed by a black draught, is given, and the patient is kept on a fluid, unstimulating diet. This is generally all that is necessary. If the patient is young and robust, and the pain very severe, one of the superficial veins of the scrotum may be opened and three or four ounces of blood abstracted. This will give immediate relief to the pain, but is not often required. If the patient is less robust and the pain severe, a morphia suppository will often relieve it. When all pain and tenderness have subsided, the testicle should be strapped, and the pressure of the strapping will usually speedily get rid of the inflammatory effusion. The patient may then be allowed to get about, wearing a suspensory bandage, and this should be continued until all induration has disappeared.

Chronic inflammation of the testicle, or **sarcocele,** may be simple, syphilitic, or tuberculous.

1. **Simple sarcocele,** or chronic inflammation of the testicle, not arising from syphilis or tubercle, is an induration of the testicular connective tissue, the result of acute inflammation. It is undoubtedly very rare; most of the cases which were formerly regarded as being cases of simple orchitis now being regarded as due either to the tuberculous or syphilitic dyscrasia. The inflammatory material which is effused during an attack of acute orchitis is not entirely absorbed, but becomes developed into a fibroid tissue, which increases the bulk of the testicle, and at the same time compresses the vessels and tubuli seminiferi. Later on, as this tissue contracts, it causes atrophy of the testicle, obliteration of the tubuli seminiferi, and consequent sterility, if both testicles are involved, but as a rule only one is affected. Occasionally simple chronic inflammation may terminate in suppuration; an abscess forms, and this may lead to hernia testis.

Symptoms.—An enlargement of the testicle remains after an acute inflammation, accompanied by a heavy dragging pain. The enlargement is smooth and uniform, and both body and epididymis are involved. The organ is tender to the touch. The cord is generally thickened, and in most cases there is an effusion of fluid into the tunica vaginalis.

Treatment.—The treatment consists in maintaining well-applied pressure by carefully adjusted strapping. This will generally succeed in diminishing the swelling. If any fluid is present in the tunica vaginalis, this should be removed by tapping before the strapping is applied. In those cases where this does not succeed in curing the patient, and the condition is a source of annoyance and discomfort, the testicle must be removed. It is probably useless, and therefore there can be no objection to this proceeding.

To strap a testicle.—In strapping a testicle care must be exercised to apply the strapping evenly and firmly, but at the same time not too tightly, so as to strangulate the parts. The skin should be shaved, and the testicle drawn well down to the bottom of the tunica vaginalis and isolated from its fellow. A strip of lint is wound round the scrotum, immediately above the testicle, to prevent its slipping up again. Strips of strapping, half an inch wide, are applied vertically over the testicle from the back to the front and from side to side until the whole organ is enveloped. A long strip is then wound horizontally round the testicle from as near the lower extremity as is possible to the level of the piece of lint which encircles the scrotum above the testicle.

2. **Syphilitic sarcocele.**—The testicle may be affected with syphilis both in the acquired and the congenital form of the disease. In the **congenital form** it is not common. It consists of a chronic inflammation of the connective tissue between the tubules, similar to the interstitial variety of the disease, which will be immediately described as occurring in the acquired form of syphilis. It is not, however, attended by so much enlargement of the organ; is usually symmetrical, both glands being simultaneously attacked; very often involves the epididymis; and frequently terminates in atrophy.

The **acquired form** occurs in two of the stages of syphilis. It may be present during the early secondary stage, though this is comparatively rare; more commonly it is found during the tertiary stage or during the intermediate period between the secondary and tertiary stage, and is then one of those conditions to which Mr. Jonathan Hutchinson has given the name of *reminders* (page 189). Syphilitic disease of the testicle, occurring during the secondary stage of syphilis, affects the epididymis. It consists in the formation of a localised nodular mass, usually in the globus major. The mass never attains a large size, grows slowly, and causes little or no pain. It is usually associated with hydrocele, which generally draws attention to the lump. It disappears under the influence of mercury.

Tertiary syphilitic sarcocele occurs under two forms: (1) as a diffuse or interstitial orchitis; (2) as a gummatous tumour. Both these forms affect the body of the testicle, and the epididymis undergoes but little or no change. It usually attacks one testicle in the first instance, but not infrequently the other testicle becomes subsequently affected. The interstitial variety consists in a chronic inflammation of the intertubular connective tissue, attended by a round-celled infiltration, which becomes converted into a dense fibroid material, that displaces the normal gland structure, and by its contraction produces atrophy of the organ. Upon making a section through a testicle affected with this disease, the tunica albuginea will be found to be much thickened, and from its internal surface thick white bands will be seen radiating into the substance of the organ; in some instances so numerous that no gland substance can be seen, and the whole organ appears to be a dense, opaque, fibrous mass, irregular and puckered on its surface from the contraction of these bands. Hydrocele is very frequently associated with it, and under these circumstances the tunica vaginalis is also thickened. If there is no fluid in the sac of the tunica vaginalis, it will generally be found that the visceral and parietal layers are adherent, the inflammation affecting the body of the testicle having extended to this covering and caused adhesion.

In the gummatous variety, in addition to the interstitial form which involves the organ, there are localised masses of gummy deposit of a yellow colour and leathery consistence. They are usually multiple. They have a tendency, like gummata elsewhere, to soften and break down, and the scrotal tissues become adherent; they give way and form an ulcerated cavity, from which exudes a wash-leather slough.

Symptoms. The disease comes on insidiously, without pain; the patient often discovering accidentally that the one testicle is larger than the other. The enlargement is slow, but progressive, until the testicle becomes twice its normal size or even larger. It involves the body of the gland, which becomes globular in shape; very hard and stony to the feel; sometimes irregular or nodular on the surface. The condition is painless, except for the dragging sensation which it produces from its weight. It is not tender to the touch, and after a time all testicular sensation is lost. The cord is unaffected and the scrotal tissues are normal, unless softening of a gumma has taken place. There may be fluid in the tunica vaginalis, but this is not often sufficient to obscure the outline of the testicle.

Treatment.—The treatment of syphilitic testicle depends in a great measure upon whether the patient has had a thorough mercurial course. If the disease is of the interstitial form, and has come on as a 'reminder,' and there is not evidence of his having had a sufficient course of mercury, this drug should be given by the mouth for a considerable period. If, on the other hand, the disease has come on at a later period of the syphilitic history, and the patient presents evidence of cachexia, iodide of potassium with tonics, change to the seaside, and any means which will improve the general health, is the line of treatment to adopt. In addition to this, mercurial inunction, combined with a certain amount of pressure, is a useful adjunct. A long strip of lint should be spread with oleate of mercury or blue ointment, and wrapped round the enlarged organs every night with such a degree of tightness as to make a fair amount of pressure. When treated early, syphilitic sarcocele generally terminates in recovery; but if not treated, it usually results in destruction of the secreting structure of the organ. When a gumma softens and bursts, hernia testis may result.

3. **Tuberculous sarcocele.**—Chronic tuberculous inflammation of the testicle may occur at any age, but is most frequent in the young adult. It may be either a primary affection or secondary to tuberculous disease in some other part. When it occurs as a primary disease, it is due to the location of the tubercle bacillus in a testicle, which affords a suitable nidus for its growth and development. Accordingly we find that tuberculous disease often attacks a testicle whose structure has been vitiated by a gonorrhœal epididymitis, or where some injury has set up an inflammatory condition which has deteriorated the structure of the organ. The disease almost invariably commences in the epididymis, in which generally a single nodule is first to be felt in the globus major; subsequently other nodules appear in the body, and these coalesce, so that the whole epididymis is converted into a hard irregular mass. Later on this caseates and breaks down; the scrotal tissues become adherent to it, and, giving way, discharge curdy pus, and leave a fistulous opening.

which may become the seat of a hernia testis. In the early stage, if a section is made, the epididymis will be found studded with semi-transparent nodules. Later on, the whole of it will be occupied by a cheesy mass, which in its centre may be softened and liquefied. By this time, in many cases, the disease will have spread to the body of the organ, and this will be seen to be secondarily involved. The disease also extends up the vas deferens to the vesiculæ seminales, and from them may extend to the bladder and eventually to the kidneys, and the whole of the urinary tract may become involved (fig. 392).

Symptoms.—The symptoms are at first slight and insidious; a little uneasiness or tenderness in the testicle may draw the patient's attention to the part, and he will discover a small lump in the epididymis: or the growth may be discovered quite accidentally. Later on the whole of the epididymis will be felt to be enlarged and to have become hard, nodular, or craggy. The body of the testicle at this time may be unaltered, or it may be felt to be softer and more diffluent than natural, and then little nodules may be found in it, especially towards the mediastinum. The vas deferens is felt to be enlarged and usually beady, the other constituents of the cord being natural. There is little pain, but a certain amount of tenderness is complained of. As a rule, there is little or no effusion into the tunica vaginalis. The progress of the disease is usually slow, but eventually the hard craggy epididymis softens in places. The skin over it becomes red

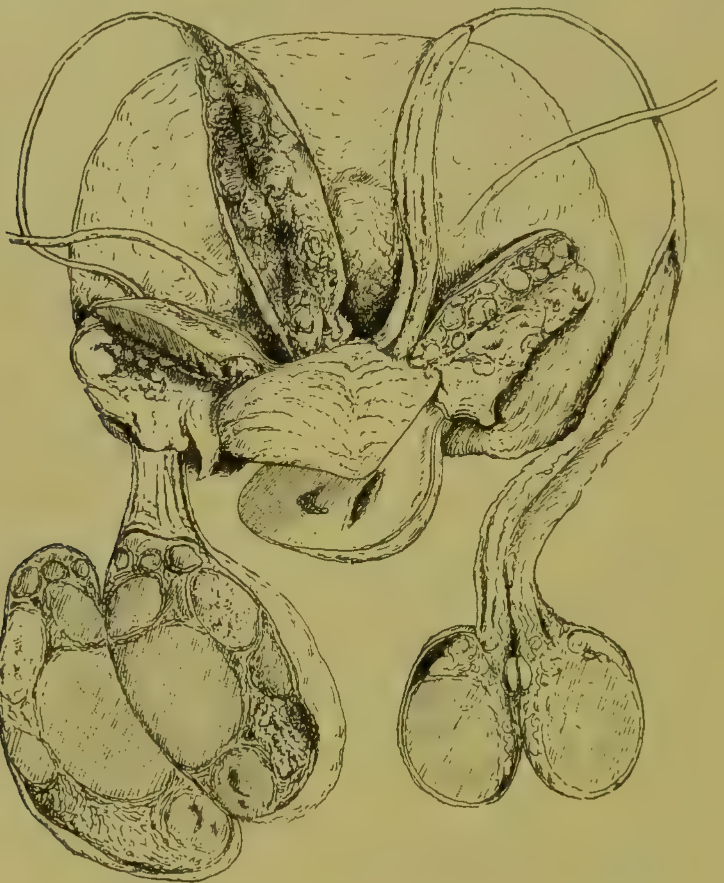

FIG. 392.—Tuberculous disease of the testicle, involving the seminal vesicle. (From the Museum of St. George's Hospital.)

and glazed, and then gives way, and a discharge of curdy pus takes place. The openings thus formed contract into fistulous tracks, which constantly discharge a small amount of puriform fluid.

There are no special symptoms by which implication of the vesiculæ seminales is indicated, but the enlargement of these bodies can be felt by digital examination through the rectum, and this should always be done before the line of treatment is decided upon and a prognosis given. After the disease has extended to the bladder, pain, great irritability of the bladder, and dysuria supervene (see page 956).

The **prognosis** of tuberculous testicle is very bad. In the majority of cases the patient dies either from general dissemination, phthisis, or extension of the disease to the bladder and kidneys. Occasionally, however, one meets with instances where the disease remains local, and after a time any caseating cavities which have formed heal up, and the patient may live to old age with a withered testicle.

Treatment.—There is some difference of opinion among surgeons as to the treatment of tuberculous testicle. Some surgeons hold that as soon as the disease is recognised, the testicle should be removed; others think that in the first instance medical treatment should be adopted if the disease is seen in the early stage, before caseation has commenced. I must confess to being of the latter opinion, certainly among the better class of patients, who can afford to carry out the medical treatment in its entirety. In spite of the removal of the testicle a large percentage of cases die, and especially in those instances where the vas deferens and vesiculæ seminales are involved, so that the whole of the disease cannot be extirpated, and it is an undoubted fact that a certain percentage of cases do recover when medical treatment is fully carried out. The great essential in the constitutional treatment of this disease is plenty of fresh air, and especially sea air. The patient should reside at the seaside, or what, in some respects, is better, take a long sea voyage, and should be almost constantly in the open air. If he is on land, he should sleep in a well-ventilated bedroom, with the window always open day and night; if he is at sea, his cabin should also be carefully selected and well ventilated; the principal objection to a sea voyage being the small and stuffy cabin in which the patient has to pass the night. The diet should be carefully regulated; plenty of easily digestible, nourishing food should be given. Salt-water baths, or in summer sea bathing, should be recommended, and in fact everything should be done which will improve the health and hygienic surroundings of the patient. In the way of medicines, cod-liver oil, iron, especially the syrup of the iodide of iron, and other tonics should be given. Iodoform in pills two or three times a day sometimes appears to do good, if it does not upset the stomach. The local treatment consists simply in supporting the testicle in a suspensory bandage. If in spite of this treatment no improvement takes place, but the tuberculous nodules begin to soften, indicating that caseation has taken place, operative interference will have to be resorted to. This may consist in either castration or erasion; of these castration holds out the best prospect of ultimate success, especially in those cases where the seminal vesicle is not enlarged and indurated; but even where this organ is enlarged, castration should still be resorted to, as cases are occasionally met with where after removal of the testicle, and therefore the original focus of the disease, the enlargement of the vesicle gradually subsides. In operating in these cases, as much of the vas deferens as is possible should be removed. Erasion should be reserved for those cases where sinuses exist, and both testicles are involved. The scraping should be very thorough, and every particle of diseased tissue should be removed. The cavity is then to be dusted with iodoform and stuffed with iodoform gauze. Under these circumstances it will occasionally close by granulation, and the wound heal.

The **diagnosis** between simple, syphilitic, and tuberculous sarcocele is not always easy. In the accompanying table the main points of difference between the three diseases have been arranged :

Simple.	Syphilitic.	Tuberculous.
Both body and epididymis involved.	Confined to body.	Begins in epididymis.
Enlargement smooth and uniform.	Indurated, irregular, and hard.	Nodular with spots of softening.
Painful and tender.	Neither painful nor tender.	Not painful as a rule, but tender.
Cord thickened.	Cord natural.	Vas thickened, other constituents of cord natural.
Occasionally fluid in the tunica vaginalis.	Frequently fluid in the tunica vaginalis.	Rarely fluid in the tunica vaginalis.
Patient gouty or rheumatic, or history of injury or gonorrhœa.	History of syphilis or syphilitic manifestations.	Tuberculous family history. Other evidence of tubercle.

Hernia testis.—Hernia testis is a protrusion of the tubules of the testicle through an opening in the tunica albuginea, infiltrated and mixed with granulation tissue. It occurs in cases of septic wound of the testicle which have gone on to suppuration ; or cases of chronic abscess, whether simple or tuberculous, which have perforated the coverings of the testicle and discharged externally ; or it may occur after the breaking down of a gummatous deposit in syphilitic disease. The perforation of the capsule having taken place, the tubules are forced out through the opening in consequence of the pressure to which they are subjected on account of the inflammatory material which has been effused in the interior of the organ. In this way the whole of the secreting structure of the testicle may be protruded and nothing remain but the shrunken capsule and the remains of the epididymis. It appears in the form of a yellowish-red, somewhat mushroom-shaped mass, projecting from one surface of the testicle, which discharges pus. It usually increases slowly, and is fairly firm and hard. It differs from fungus hæmatodes, the fungous protrusion of a malignant growth of the testicle, in its rate of growth and in its microscopic characters, consisting merely of the seminal tubules in a mass of granulations, whereas the fungus hæmatodes presents the characters of the new growth.

Treatment.—Hernia of the testis, if small, should be treated by pressure and by maintaining as strict asepticity as possible. The parts should first be thoroughly cleansed with solution of corrosive sublimate, then dusted with iodoform and covered with two or three layers of gauze, and carefully strapped so as to maintain firm pressure over the protruding part. Sometimes it is advisable before applying the dressing to shave off the herniated part. Some surgeons recommend that the protrusion should be shaved off, and the edges of the skin on either side rawed, and then brought together by sutures over the site of the hernia, but the operation is rarely attended with any success. When the protrusion is of large size, and the greater part of the gland has escaped from its covering, it is better to remove the testicle, since it is practically useless, and will be a constant source of annoyance and discomfort to the patient.

Tumours of the testicle.—The only innocent tumour of the testicle which is at all common, is the adenoma or fibro-cystic tumour ; the malignant tumours may be either sarcoma or carcinoma.

The **adenoma** or fibro-cystic tumour is characterised by the formation of a number of cysts, of varying size, scattered throughout the substance of the organ. The cysts are rounded or tubular in shape, lined with epithelium, which is sometimes cubical, sometimes stratified, and often contain secondary intra-cystic growths. They frequently inter-communicate with each other. The contents of the cysts varies ; it may be clear and serous, mucoid and thick, or mixed with blood (fig. 393). The cysts are held together by a stroma of connective tissue, in which is often a certain amount of cartilaginous tissue, disposed in nodules or tortuous columns. This connective tissue may undergo sarcomatous changes, and the tumour may become malignant. Hence they were formerly called *cystic sarcomata*. Upon making a vertical section through a testicle, the seat of this disease, a double capsule will be seen, and between the two a layer of a brownish-yellow material. The external capsule is the tunica albuginea ; the internal capsule is the true investing capsule of the tumour, while the material between the two is the secreting structure of the testicle, which is spread out as a thin layer over the surface of the tumour. This throws some light on the pathology of the disease, the tumour being believed to be an outgrowth from the organ of Giraldes, which is the remains of the Wolffian body, situated in the neighbourhood of the globus major of the epididymis, and which grows into the body of the testicle, pushing the testicular substance before it.

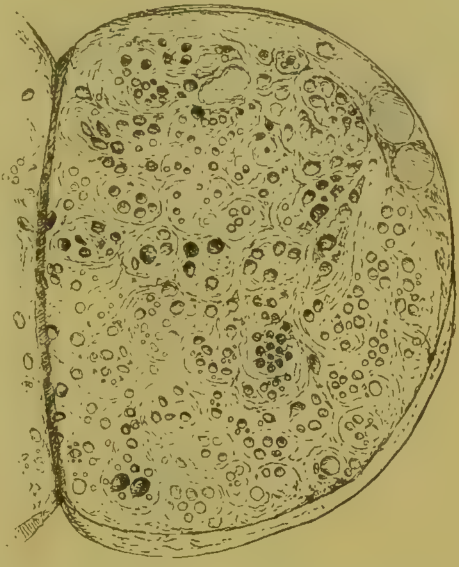

FIG. 393.—Cystic adenoma of the testicle. (From the Museum of St. George's Hospital.)

Symptoms.—The symptoms of the disease are the history of a gradual and progressive enlargement of the testicle without pain in a young adult. There may be no assignable cause, or it may be attributed to an injury. The enlargement is globular, smooth, and elastic, and there is, as a rule, an absence of testicular sensation. It gives rise to no inconvenience, except from its weight and size. If not removed, it may attain a very large size, though its growth is slow, and eventually the skin over it may give way, especially if it takes on a malignant type. It may be mistaken for a hæmatocele, or an old hydrocele with a thickened sac, which is not translucent. The diagnosis must be made from the shape, which is globular and not pyriform, and by the detection of the testicle at some part of the swelling in hydrocele. An exploratory incision should always be made before removal, as the diagnosis can never be certain. The only treatment is castration.

Among other innocent tumours of the testicle are chondroma, fibroma, and dermoid cysts. They require no special description, as they are of rare occurrence.

Sarcoma of the testis sometimes occurs as a primary condition independently of the sarcoma which invades the cystic disease just described It is met with in children and middle-aged men. In the former it is of the round-celled variety and runs a rapid course. In the adult it may be of the spindle-celled variety, and undergo developmental processes, and become converted almost as rapidly as it is formed into cartilage; so that the tumour is found to consist on section of cartilage surrounded only by a thin stratum of sarcomatous tissue. The cartilage in its centre undergoes myxomatous and cystic degeneration and a cavity may be formed there.

The disease begins in the body of the gland, causing its enlargement, and at first shows itself as a rounded swelling, which is soft, and not to be distinguished from encephaloid disease of the testicle. Later on it may become nodulated, and, if cartilage is formed, hard but elastic. Secondary growth takes place in internal organs and in the lumbar glands. The patient complains of dragging pain, and becomes wasted and cachectic. Later on the skin of the scrotum, which has become thinned by the pressure of the growth, gives way and the tumour fungates and bleeds.

Carcinoma of the testicle is usually of the encephaloid type. It begins in the body of the organ, infiltrating its structure and extending through its coverings to the scrotal tissues (fig. 394). These give way, and a fungous protrusion takes place which grows rapidly and bleeds freely, constituting what used to be known as *fungus hæmatodes*. It spreads up the cord, which becomes thickened; invades the lumbar glands, and death rapidly ensues from exhaustion and hæmorrhage.

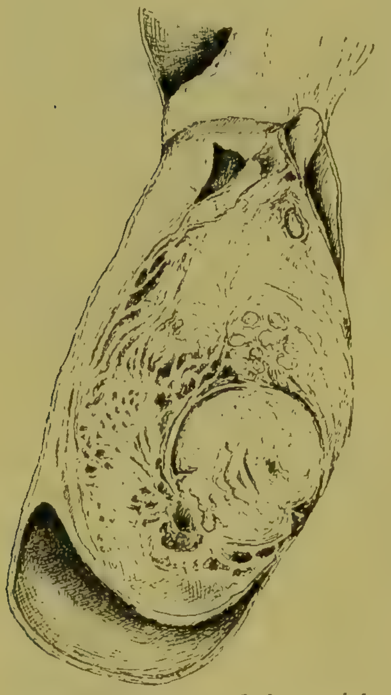

FIG. 394.—Cancer of the testicle. (From the Museum of St. George's Hospital.)

Symptoms.—The patient complains of a dragging pain in one testicle, and the organ is found to be enlarged, though at first retaining its normal shape. The enlargement is rapid and progressive. The veins of the scrotum become prominent, and, after a short time, the skin reddened and tense, and then adherent to the tumour. The cord can be felt to be swollen and thickened, and its constituents matted together. The **diagnosis** rests on the fact that there is a rapidly increasing solid enlargement of the testicle, unaccompanied by any signs of inflammation. It is not easy, however, in the early stage to diagnose it from other scrotal swellings, and whenever the surgeon meets with this condition —namely, a rapidly increasing solid swelling —an exploratory incision should at once be made, since it is only in the very earliest stage that any operative interference can be of any avail.

The only **treatment** of malignant tumours of the testicle is the speedy removal of the organ.

Castration.—The operation of castration may be required for malignant disease of the testicle, tuberculous testicle, old hæmatocele, retained or malplaced testicle, enlarged prostate, and, perhaps, more rarely for old syphilitic disease of the organs, and after some injuries.

The operation is a simple one. The parts having been shaved and rendered aseptic, the scrotum is seized from behind with the left hand, so as to render the skin tense, and an incision is made from the external abdominal ring to the bottom of the scrotum. If the testicle is adherent to the skin, or there is any suppurating sinus, two semilunar incisions should be made, including this part. At the upper end of the incision the cord must be exposed and isolated, and if it is healthy an aneurism needle should be passed through it, armed with a stout silk ligature, and the cord tied in two halves, and divided below the ligature. If the cord is not healthy at the external ring it must be followed up the inguinal canal, tied, and divided as high as possible. After the cord has been divided, the testicle is easily shelled out of the scrotum by the finger, assisted by a touch or two of the knife. After all hæmorrhage has been arrested, the wound is closed with horsehair sutures, a drainage tube being inserted at its most dependent part for twenty-four or fourty-eight hours. Care must be taken in the after treatment to prevent the dressings being soiled by the urine.

INJURIES AND DISEASES OF THE SPERMATIC CORD

Acute inflammation of the cord.—Inflammation of the cord may be the result of injury, or may commence in the vas deferens as an extension of gonorrhœa from the urethra, and spread to the other constituents of the cord. It is characterised by a rapid, painful swelling, and when abscess forms, the skin over it becomes red and œdematous, and fluctuation is perceived. The treatment consists in the application of hot fomentations and incisions as soon as suppuration has taken place.

Chronic inflammation is usually tuberculous, secondary to a similar condition of the testicle. The vas deferens becomes enlarged and nodular, and then one or more of the nodules undergoes caseation, and a rounded swelling is formed in the substance of the cord, which slowly softens into a fluctuating swelling, and after a time bursts and discharges curdy pus. The **treatment** must vary according to the condition of the testicle. If a caseating or discharging focus exists in the testicle, this organ and the vas deferens, to as great an extent as possible, should be removed. The inguinal canal should be opened to its fullest extent, and it may be even considered desirable to open the abdomen and trace the vas backwards to the base of the bladder. If the testicle is in a quiescent condition, it may be worth while to attempt first, by scraping the suppurating focus, to get rid of the disease. This operation can be rarely satisfactory, for it must be remembered that the function of the testicle will be destroyed by the obliteration of its duct.

Hydrocele of the cord is an effusion of serous fluid into the cord, usually enclosed in a distinct cyst, when it is known as *encysted hydrocele* of the cord, or possibly diffused among the cellular tissues of the cord; this is *diffuse hydrocele* of the cord.

Encysted hydrocele of the cord.—The cyst in these cases may be formed in two ways: (*a*) Where a small portion of the funicular process of peritoneum remains unobliterated, a little cavity is formed, and in this serous fluid accumulates, and so the encysted hydrocele is formed. In some cases the obliteration is very imperfect, the funicular process being only obliterated at its two ends (see page 883). Then the cystic tumour is much greater, and forms a sausage-shaped swelling, which distends the inguinal canal, and projects into the scrotum. This condition is, however, very rare. (*b*) The cyst may result from the formation of an independent cyst in the cellular tissue of the cord, from a distension of one of its cyst spaces. The disease is commonest in boys about the age of puberty, or in young adults.

Symptoms.—The unobliterated portion of the funicular process is generally situated in the upper part of the scrotum, just below the external abdominal ring, and in this situation will be found a small, round, tense swelling, which has often the consistence and feel of a testicle, and has sometimes been mistaken for a third gland. It is separable from the testicle below, and generally from the external ring above, or it may extend through it into the inguinal canal. It is then somewhat difficult to diagnose it from a hernia, as it is reducible, and can be pushed backwards into the abdominal cavity.

The **diagnosis** may be made by observing the behaviour of the testicle when the swelling is reduced. It will be noticed to ascend in the scrotum, whereas in the reduction of a hernia the testicle remains stationary. The encysted hydrocele is, moreover, dull on percussion, has no impulse on coughing, and is not reduced with a gurgle, but is pushed bodily back into the abdomen. Occasionally its translucency may be detected.

Treatment.—In very young children the application of a discutient lotion (chloride of ammonia) will effect a cure. In older boys tapping has sometimes succeeded, but is very uncertain; and tapping with the injection of iodine is not always safe. The best treatment is to dissect out the cyst, care being taken not to injure the other constituents of the cord.

Diffused hydrocele of the cord.—This condition was described by Pott. It is very rare, and would appear to be merely a dropsy of the cellular tissue of the cord.

Hæmatocele of the cord is a very rare disease and scarcely requires mention. It appears usually to arise from the rupture of a varicose spermatic vein from some severe strain or blow. Blood is extravasated into the constituents of the cord, and forms a swelling along the inguinal canal into the upper part of the scrotum. The blood may become encysted and remain for years. The **treatment** consists, in the early stage, in rest and applying evaporating lotions, and, if the blood is not absorbed, in an antiseptic incision.

Varicocele, as it name implies, consists of a varicose condition of the pampiniform plexus of veins. It is an affection of puberty and early manhood, rarely appearing after the age of thirty-five, and is much more common on the left side than on the right; varicocele of the right side alone being almost unknown.

Pathology.—The veins become enlarged, elongated, and tortuous: their coats are for the most part thickened, but places are sometimes to be seen where the walls are thinner than normal. The varicosity rarely affects the veins in the inguinal canal, but is mainly confined to the scrotal portion of the vessels, where they lie unsupported in a loose connective tissue.

Causes.—The theories which have been assigned as the cause of varicocele are very numerous. By some the cause is believed to be a congenital abnormality or malformation in the spermatic veins; by others, an over-development of the veins; while others again have considered that they are caused by various anatomical conditions, such as: (1) their want of support in the loose cellular tissue of the scrotum; (2) their great length, tortuosity, and dependent position; (3) the constriction to which they are subjected in their passage through the abdominal wall. Lastly, masturbation is frequently spoken of as a cause, from its producing an abnormal vascularity of the testicle. Some, however, regard the masturbation as the effect, and not the cause, of the varicocele.

Various causes have been assigned for the greater frequency of varicocele on the left side. The left spermatic veins opening into the left renal at a right angle; the left spermatic veins being a little longer than the right; and the pressure of fæcal accumulation in the sigmoid flexure pressing on the left spermatic vein, have all been given as causes. Lately it has been asserted that in the fœtus and young child the veins of the left side are more numerous than on the right, and if the congenital theory of the origin of varicocele is the right one, this would explain its greater preponderance on the left side.

Symptoms.—The symptoms are a well-defined swelling lying along the course of the spermatic cord, which on handling feels like a bag of earthworms. The swelling is soft and compressible, has a distinct impulse on coughing, and disappears, or greatly diminishes, when the patient lies down, and reappears when he assumes the erect position, even though firm pressure is made over the external abdominal ring. The scrotum is generally relaxed and flabby, and when this is so the varicose veins can be seen, and the disease at once recognised, without even touching the scrotum. There is often a sensation of weight or dragging, sometimes amounting to real pain of a dull, aching character, and this is generally worse after fatigue or exhaustion. The testicle on the affected side is sometimes smaller and softer than on the other, but in most cases is absolutely normal. In these cases there is often a considerable amount of mental disquietude and distress, out of all proportion to the local trouble, and the patient worries himself by apprehensions of impotence or impaired virility.

Treatment.—The treatment may be either palliative or operative. In the vast majority of cases the former is all that is necessary. If the patient can be persuaded that the condition is one of no importance, the wearing of a well-fitting suspensory bandage will relieve him of any dragging pain from which he may suffer, and no other treatment is necessary. But there are certain cases where operative treatment is to be recommended. These cases are (1) those of young men who desire to enter one of the public services, and are ineligible as long as they are the subjects of varicocele; (2) cases where the varicocele causes much pain or physical distress, which is not relieved by wearing a suspensory bandage; and (3) where the disease produces mental distress, the operation may be performed as the best means of relieving the patient from his condition of mental disquietude.

The best mode of operating for the cure of varicocele is by excising a portion of the veins and suturing the two cut ends together. The operation is thus performed: The parts having been shaved and thoroughly cleansed, the surgeon grasps the scrotum, containing the spermatic cord, with his forefinger and thumb, and allows the skin to gently recede under them until he feels the vas deferens slip, like a piece of whipcord, under his finger. An assistant now takes charge of the scrotum, seizing it with his two forefingers and thumbs, about three inches apart, between the spermatic veins, which lie superficially under the skin and the vas deferens. The surgeon makes an incision over the prominent veins between the two hands of the assistant, and exposes the thin fascia covering them. An aneurism needle armed with a double ligature is now passed around the fascia with its included veins; and the thread being held, the aneurism needle is withdrawn. By pulling on the ligature the veins are raised from their bed and must be freed from surrounding parts, by a few light touches of the knife, for the extent of about two inches. The double ligature is now divided in its middle. One portion is drawn downwards to the lowermost point of the denuded veins and securely tied; the other passed to the uppermost point, and in the same way tied. The portion of veins between the two ligatures is now excised, leaving a sufficient amount of stump beyond the ligature to prevent its slipping. The two stumps are brought together and fixed to each other by one or two catgut sutures, passed through them below the level of the ligature. Any bleeding points are then secured, the wound well irrigated with corrosive sublimate solution, and the external wound closed with horsehair sutures. The parts are dressed in the usual way, and the dressing may be left on for a week or ten days, when the wound will be found to be healed, and the stitches may be removed.

The patient should be instructed to wear a suspensory bandage for three months afterwards, until the cicatrix is quite consolidated.

Tumours of the spermatic cord.—The most common tumour of the spermatic cord is the lipoma, growing from the scattered nodules of fat normally found in this structure. They grow slowly, are painless, and are only of importance because they are liable to be mistaken for hernia. They can be at once recognised by the fact that they are connected with the cord, so that if the testicle is fixed, it is impossible to push them upwards into the abdomen. Other tumours of the cord are the myxomata and the fibromata, but they are very rare. Malignant tumours may affect the cord, spreading upwards from the testicle, and it is said that primary sarcoma may occur in the cord.

DISEASES OF THE VESICULÆ SEMINALES

Inflammation.—The vesiculæ seminales may be the seat of inflammation, which may be acute or chronic.

Acute inflammation is generally found as a complication of acute prostatitis, the result of gonorrhœa, but may also occur from other forms of urethritis; from stricture, or from catheterism; but appears always to be associated with inflammation of the prostate. The **symptoms** are much the same as those of prostatitis: deep-seated pain in the perineum, painful and frequent micturition, and pain on defæcation; but in addition to these there is persistent priapism, and occasional emissions, the semen often being blood-stained. Upon examination by the rectum, the enlarged vesicles can be felt, and will be found to be exquisitely tender. The inflammation usually runs on to suppuration, the abscess bursting into the rectum, with immediate relief to the symptoms. The **treatment** consists in hot baths, fomentations to the perineum, and the administration of saline aperients. As soon as suppuration has taken place, an incision should be made into the abscess, either by a bistoury, guarded by the finger, introduced into the rectum, or by a deep incision in the perineum.

Chronic inflammation is the result of the same causes as the acute, most frequently occurring from gonorrhœa during its gleety stage. There is pain in the perineum, often referred to the hip, sacrum, or back, and greatly increased by defæcation and micturition. There may be seminal emissions and priapism. The enlarged vesicle, or vesicles, can be felt by rectal examination. The **treatment** consists in treating the cause, attention to the general health, sea-water bathing, cold douching, and tonics.

Tuberculous disease is rare as a primary affection, but very common as a sequel to tuberculous disease of the testicle. On rectal examination the vesicle or vesicles can be felt to be enlarged, and extending upwards and outwards from the back of the prostate. When the tuberculous material caseates and breaks down it may burst either into the bladder or rectum, or not uncommonly into both, causing a recto-vesical fistula. When the disease is primary the vesicle should be scraped out, or removed by a semilunar incision in the perineum, just in front of the anus, and the dissection carried upwards between the rectum and prostate. When the disease is secondary to tuberculosis of the testicle, the treatment can be only palliative.

Spermatorrhœa.—By the term *spermatorrhœa* is meant a discharge of semen without sexual desire or excitement. The patient's condition is often regarded as being the direct result of the seminal loss, rather than a hypochondriacal condition, which has been set up by an irritable state of the sexual organs, causing frequent emissions. The term is often much abused, and is constantly applied to discharge of mucus—urethral, prostatic, or vesical—or to a gleety discharge from the urethra.

Causes.—The causes which may give rise to this condition are several: habits of self-abuse, balanitis, phimosis, varicocele, hæmorrhoids, fissure of the anus, the irritation of worms, constipation, and dyspepsia.

Symptoms.—Spermatorrhœa begins with nocturnal emissions, at first with, and after a time without, erotic sensations. The patient becomes weak and irritable. Then emissions take place in the daytime, from friction of the trousers, or whilst straining at stool. If sexual intercourse is attempted, emission takes place almost immediately, and the patient fancies himself to be impotent; he broods over the subject, and mental disquietude is the consequence. As a result of this condition his digestion becomes impaired, he suffers from flatulency, heartburn, oppression of breathing, and constipation, with aching pains in the loins, and at last he develops hypochondriasis, which may drift into a condition of melancholia.

The disease is characterised by 'sexual irritability, mental uneasiness, dyspepsia, and hypochondriasis' (Gascoyen).

Treatment.—The first point in the treatment is to ascertain the cause, and endeavour to remove it. If it is due to habits of self-abuse, these must be at once given up, otherwise treatment will be of no avail. If there is a varicocele, a tight foreskin, or piles, they must be operated on, and any cause which it may be judged might have given rise to the condition removed. After this the main treatment must be directed to the patient's general health. He should abandon all sedentary habits, and live a healthy outdoor life, and keep his mind occupied. He should sleep on a hard bed and rise early, as soon as he wakes. He should take cold baths, or, if possible, have sea bathing. His diet should be nourishing, but unstimulating, and he should take no supper or late meal. His bowels should be educated to act last thing before retiring to rest. As regards medicine, the bromides are sometimes of use, and the administration of the liquid extract of black willow in drachm doses, as recommended by the late Mr. Berkeley Hill, is often attended with great benefit. The local treatment which is most frequently advocated is the application of a solution of nitrate of silver to the prostatic urethra by means of a syringe catheter. In my hands it has proved absolutely useless.

DISEASES OF THE BREAST

Diseases of the breast in the male are rare, at all events in comparison with diseases of the same organ in the female. When they do occur, they imitate similar affections in the female, which will be described in the sequel.

In boys about the age of puberty the breast sometimes swells and becomes painful, constituting *mastitis*. This may go on to abscess, the exciting cause then being in most cases a blow. The disease usually subsides on the application of extract of belladonna and glycerine, followed by a hot fomentation, but if it goes on to suppuration, the abscess must be opened. Chronic interstitial mastitis is occasionally met with in the male breast, and this may be complicated with the formation of cysts.

Carcinoma of the male breast is perhaps more common, and is usually of the spheroidal cell type, though epithelioma of the nipple is occasionally met with. These require removal in the same way as when a similar disease affects the female breast

CHAPTER XVII

INJURIES AND DISEASES OF THE FEMALE GENERATIVE ORGANS

INJURIES AND DISEASES OF THE VULVA

Contusions of the vulva may be caused by falls on any projecting object or by kicks, or by a direct blow on the part. Owing to the lax and vascular nature of the tissues injured, a large extravasation of blood takes place, which is known by the name of *hæmatoma*. They may also be caused by the rupture of a varicose vein, especially during parturition. The vulva becomes enormously swollen, and of a dark purple or black colour, and is hard and firm to the touch. As a rule the blood is absorbed without trouble, but occasionally it may suppurate.

The **treatment** consists in rest, the application of cold lotions or an ice bag; and if swelling persists, or signs of suppuration ensue, an incision should be made, and the contents evacuated; the cavity is then washed out with some antiseptic solution, iodoform sprinkled over it, and it is stuffed with gauze. As careful antiseptic precautions as is possible are to be taken.

Wounds of the vulva may be produced by falls on pointed objects, by kicks, and frequently by a chamber utensil, on which the patient is seated, breaking. Lacerations may also occur during labour, or from the use of forceps. The wounds are generally lacerated and bleed freely. They must be carefully cleansed with antiseptic lotion, the edges accurately adjusted with sutures, and as strict antiseptic measures as is possible adopted.

Rupture of the perineum is an accident which occasionally takes place during labour. It may vary from a slight tear of the fourchette, which is an exceedingly common or almost invariable occurrence in a first labour, and is a matter of very little importance, to a complete rent of the perineum extending into the rectum, and tearing the recto-vaginal septum. When slight, the rupture gives very little trouble, but when extensive, from the loss of the support of the perineum, prolapse of the anterior wall of the vagina and the posterior wall of the bladder, or prolapse of the posterior wall of the vagina, with the contiguous wall of the rectum, takes place, and with this there may be a certain amount of prolapse of the uterus. And where the sphincter ani is involved, there is added to this a loss of control of the fæces. Under these circumstances the patient's life is rendered a misery to her, from the loss of control over her fæces, and from the feeling that the womb is coming down whenever she assumes the erect position or moves about. In addition to this, there is often irritability of the bladder, with frequent micturition and sexual disability, which adds to the patient's distress.

Whenever a laceration of the perineum, of greater extent than a slight tearing of the fourchette, takes place during labour, the medical attendant should at once carefully wash the parts, remove all blood clots, and bring the lacerated surfaces together with deep sutures. In the majority of cases the wound will heal, and no further trouble will be experienced. Should it not do so, and the patient finds that she suffers from any of the disabilities above mentioned when she begins to get about, secondary perinæorrhaphy should be resorted to. The operation is, however, best deferred until the general health is restored and the child weaned. Many different modes of operating have been used, but for the most part they consist in refreshing the sides of the rupture and uniting them by suture.

Perinæorrhaphy.—The patient is placed in the lithotomy position, and the skin dissected off from the sides of the fissure and the mucous membrane of the recto-vaginal septum, if it remains intact, so as to leave a rawed horseshoe shaped surface, which should extend forwards as far as the lower extremity of the nymphæ. Care must be taken that the denudation is complete. Where the recto-vaginal septum has been torn through, rectal sutures are first inserted, so as to approximate the torn edges of the septum, and restore the partition between the rectum and vagina. Then three deep sutures of carbolised silk or silkworm gut are inserted with a Baker Brown's perineal needle—that is, a needle on a handle with a long deep curve. The needle is introduced just internal to the tuber ischii on one side, is carried to the very bottom of the denuded part, and brought out near the right tuberosity. The lowermost suture of the three should be carried through the recto-vaginal septum, when it exists, without appearing in the cleft at all (fig. 14). These sutures are then tightened over quills (page 64), and the rawed surfaces brought in contact. Superficial sutures are now applied to keep the edges of the skin in contact. The parts are dusted with iodoform, and a gauze pad applied. The patient is placed on her back in bed, with her thighs flexed over a pillow, and her knees tied together. The water is drawn off periodically, and the bowels are kept confined for a week. The deep stitches may then be removed, and the bowels opened by an enema. The patient should be kept in bed for a month until the union is sound.

The late Mr. Lawson Tait devised a very simple and efficient way of operating in these cases, by separating the vaginal and rectal layers of the recto-vaginal septum from each other, and then bringing the separated surfaces together by a row of antero-posterior sutures, which are therefore at right angles to the plane of the perineum.

The operation is performed as follows: the patient is placed in the lithotomy position, and two fingers of the left hand are introduced into the rectum, to press up the septum; whilst the folds of the buttocks are held firmly apart so as to tense it. This exposes the greater part of the vaginal wall. An incision is then made along the free margin of the recto-vaginal septum, and the mucous surface of the vagina is separated from the mucous surface of the rectum by means of pointed scissors introduced between the two; by this means the recto-vaginal septum is split into two layers. From the extremities of the transverse incision two vertical incisions are made forwards to the point of junction of the labia majora to the labia minora, and backwards for about a third of an inch by the side of the anus. The incisions thus formed resemble the letter H, except that the crossbar is not in the middle, but is nearer the lower than the upper end of the letter. The anterior vaginal flap, which may be compared with a lid of a box in shape, contracts and forms an irregular semicircle, which only now partially covers the freshened surface, which is somewhat quadrilateral in shape (fig. 395). The vaginal flap is seized with forceps and held forwards, and in the same way the rectal flap is held backwards. Silkworm or silver sutures are now introduced by means of a long needle on a handle. The point of the needle is introduced on the freshened surface directly inside its left edge, and is passed transversely through the tissues and made to emerge at a corresponding point on the opposite side. Four sutures are generally sufficient; of these the anterior one should penetrate the recto-vaginal septum a little beyond the level to which it has been split. The stitches are then tied and the edges of the wound drawn together in such a way that the line of union is antero-posterior. Towards the anus there is a fold which corresponds to the middle of the posterior flap, whilst in the vagina there is a corresponding fold from the puckering up of the anterior flap. Lawson Tait did not advocate the use of any superficial sutures, but many surgeons recommend that a few superficial sutures should be inserted between the cut edges of the skin, where they are brought in apposition by the deep sutures. The rectum and vagina should be washed out daily, and the sutures may be left in situ for a fortnight or three weeks. The bowels should be kept confined for a week.

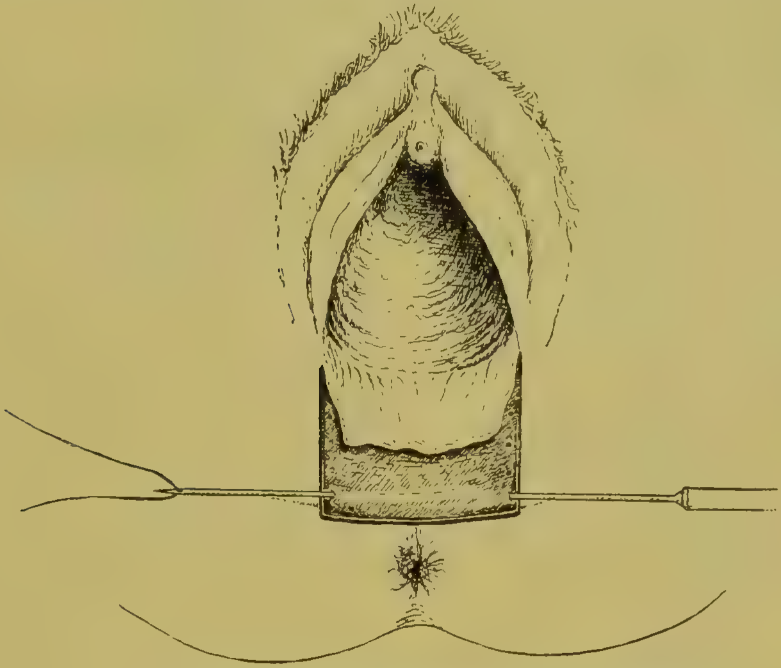

FIG. 395.—Diagram showing the manner of performing Lawson Tait's operation for ruptured perineum.

Vulvitis.—The term *vulvitis* is applied to an inflammation of the lining membrane of the vestibule. In its acute form it is generally due to gonorrhœa, but may arise also from want of cleanliness, especially in unhealthy constitutions; or may follow upon injury or severe cold. In children it is frequently caused by the irritation of worms, which find their way out of the rectum into these parts. It is characterised by swelling, itching, or smarting pain, especially during micturition or on walking;

and a purulent or muco-purulent discharge, which causes the labia to adhere together.

The **treatment** consists in rest, and attention to diet, with the administration of a saline purge. The local treatment consists in cleanliness; the parts should be douched three or four times a day with warm Condy's fluid (ʒj to Oj), and the patient should have a hot sitz bath every night. When the active symptoms have subsided, an astringent lotion should be substituted for the Condy's fluid.

Follicular vulvitis.—A special form of vulvitis has its seat of origin in the sebaceous glands of the labia majora. It originates from the same causes as ordinary vulvitis. The labia become swollen and tender, and upon examining their internal surface they are found to be studded with a number of small papules, which suppurate and burst, and discharge a quantity of foul pus. The **treatment** is the same as for vulvitis, but after each douching a pledget of wool, soaked in glycerole of tannin, should be inserted between the labia so as to keep them apart, and prevent them from irritating each other.

Abscess of the labia.—Vulvitis frequently terminates in abscess of the labium. The labium becomes much swollen, red and tense, and exquisitely tender. Severe throbbing pain is complained of, and the parts around are œdematous. There is usually a considerable degree of fibrile excitement. Later on fluctuation will be detected. The abscess must be freely opened at any spot where the skin is softening, and after the matter is evacuated, the cavity should be stuffed with gauze, to ensure healing from the bottom.

Noma pudendi.—This condition is the same as cancrum oris in the mouth, and has already been described (page 146).

Pruritus is a name given to an intolerable itching which occasionally attacks the vulva, sometimes without any obvious cause; at other times, in diabetic or gouty subjects; and in some as the result of irritating discharges. It most frequently occurs in elderly women, and is especially troublesome at night. As soon as the patient gets warm in bed the most intolerable itching attacks the vulva, which entirely prevents sleep, and which induces constant scratching, until the tissues become abraded and torn.

The **treatment** consists in removing the cause, if it can be ascertained. The local application of cocaine is the means of giving the most relief, and it will generally be found that the best way to apply it is to soak a piece of lint in a 5 per cent. solution, and insert it between the labia.

Tumours.—Many different forms of tumours affect the vulva, among which are: (*a*) *Elephantiasis*, due to obstruction of the lymphatics, which leads to an overgrowth of the connective tissue of the labia and clitoris; (*b*) *Papillomata*, which result from the irritation of discharges, and which may form large and exuberant growths, extending to the anus and down the thighs; (*c*) *Angiomata*, especially in young children; (*d*) *Lipomata*, which, originating in the connective tissue of the labia majora, or of the mons Veneris, may attain a large size; and (*e*) *Fibromata*, which occasionally become pedunculated, and are apt to ulcerate. Among malignant growths, *squamous epithelioma* is the most common, though *sarcoma*, especially melanotic sarcoma, is not uncommon.

Epithelioma occurs in somewhat advanced life, generally commencing in one labium, and rapidly extending till it affects all the tissues at the vaginal outlet, forming a foul, ulcerated chasm, which may extend into the rectum behind, and the bladder in front. The inguinal glands become speedily affected, and death occurs from exhaustion, induced by hæmorrhage, pain, and foul discharge.

The **treatment** of these various forms of tumour is removal; though with regard to excision in epithelioma, the operation does not hold out much hope of relieving the patient for long, as recurrence almost always takes place at no very distant period.

INJURIES AND DISEASES OF THE VAGINA

Atresia of the genital passage is usually due to congenital deformity, and may be of various degrees and kinds.

1. There may be occlusion of the vaginal outlet in young children, owing to adhesion of the labia together. The condition is a very simple one, and the remedy is as simple; as soon as it is discovered it should be remedied by tearing through the adhesions with a director or other blunt instrument, and placing a piece of oiled lint between the torn surfaces for a day or two, to prevent them adhering together again.

2. **Imperforate hymen.**—The hymen may be completely or partially closed. When completely closed the condition is often not discovered until the age of puberty, when the patient begins to develop the periodic disturbance which attends menstruation, without the accompanying discharge of blood, which, being prevented from escaping, owing to the imperforate condition of the hymen, collects in the vaginal canal, giving rise to a condition which is known as *hæmato-kolpos* (fig. 396). The retained blood undergoes changes and becomes converted into a black treacly fluid. Sometimes the accumulation is so great that a distinct tumour can be felt in the hypogastric region, and fluctuation perceived by a bimanual examination, one finger being introduced into the rectum, and the other hand placed on the abdominal wall. Upon examination the hymen will be seen as a tense, convex membrane, occluding the vaginal passage.

In some cases the amount of blood retained is so great, that it distends the uterus, and sometimes the Fallopian tubes.

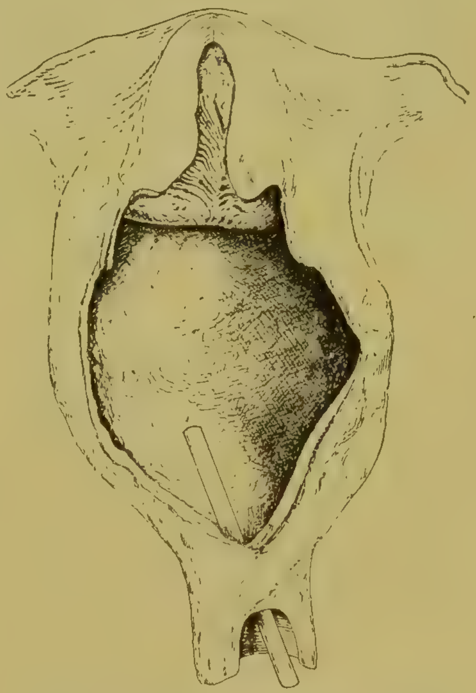

FIG. 396.—Imperforate hymen producing hæmato-kolpos. (From the Museum of St. George's Hospital.)

Treatment.—The patient having been placed in the lithotomy position and the external organs of generation cleansed, a free incision is made through the hymen, and the retained blood allowed to escape. Some surgeons prefer to make the opening with a Paquelin's cautery. As soon as the fluid has ceased to flow, the vagina should be irrigated with hot corrosive sublimate solution (1 in 5,000), until the fluid returns quite clear. A plug of antiseptic gauze should now be inserted in the opening to prevent its closing, and it should be removed daily, and the vagina irrigated. The operation is not altogether devoid of risk, and the most careful asepsis must therefore be observed.

When the hymen is partially perforate the condition may not be discovered until marriage takes place, when, as in these cases the hymen is generally very rigid and tough, the complete introduction of the male organ cannot be effected.

The **treatment** consists in introducing a probe-pointed bistoury through the small opening, and nicking the membrane in several places, and then forcibly dilating it.

3. **Atresia vaginæ.**—The vagina may be absent in whole or in part, and this may be either with or without the presence of the uterus and ovaries. The absence of the uterus may be at once ascertained by introducing a sound into the bladder and a finger into the rectum, when, in cases of its absence, the sound is felt by the finger. In these cases no treatment is necessary. In cases of atresia of the vagina, where the uterus and ovaries are present, symptoms show themselves as soon as the catamenia are established. The uterus becomes distended with blood (hæmatometra), and after a time the Fallopian tubes also become distended. Some of this fluid may find its way out through the open tubes into the peritoneal cavity, and a localised peritonitis be set up.

The **treatment** consists in trying to establish an outlet for the menstrual fluid by means of a careful dissection from the vulva. The patient is placed in the lithotomy position, and a staff introduced into the bladder to act as a guide to its position, and an incision is made over the seat of the hymen. The forefinger of the left hand is then introduced into the rectum, and with this as a guide, the cellular tissue is burrowed through with a director or other blunt instrument in an upward direction until the fluid is reached. When this is done, the blood is allowed to escape, the cavity is washed out, and the opening made is carefully packed with gauze. The channel thus made will have a constant tendency to contract, and will require the occasional passage of a gum elastic bougie through it to keep it permanently dilated.

Injuries of the vagina may be caused in several ways, viz. by the patient falling on some sharp, spiked body which enters the vagina; by the too rough introduction of the forceps or other obstetric instrument in delivery; by violence in cases of rape; or by too energetic efforts of the male in a first copulation. There is in the Museum of St. George's Hospital a preparation of laceration of the posterior wall of the vagina into the peritoneal cavity, which occurred at a first coitus.

In these cases the parts must be thoroughly exposed by a duck-bill speculum, all bleeding vessels tied, and the divided edges united by silver or silkworm-gut sutures.

Foreign bodies are constantly introduced into the vagina, and may sometimes cause laceration of the vaginal walls, or may be retained and give rise to ulceration and a stinking discharge. They may remain there for years, and may cause fistulous communications either with the bladder or rectum.

Vaginal fistulæ.—Fistulous communications between the vagina and bladder in front, or rectum behind, are not uncommon, the former being the commoner of the two. The most frequent cause of this condition is sloughing from the pressure of the head of the child during parturition; but they may also be caused by wounds of the bladder or rectum, through the vagina, or from ulceration due to foreign bodies, or some malignant growth of the bladder or rectum.

Vesico-vaginal fistulæ cause great distress to the patient, since the urine is constantly escaping and excoriates the thighs. An attempt should be made to cure them by paring the edges of the fistula and bringing them together with silver wire sutures; but the operation very often fails.

Recto-vaginal fistulæ are also the source of great annoyance to the patient, from the escape of fæces and flatus into the vagina. They show a much greater tendency to heal spontaneously than the vesico-vaginal fistula, but if they do not, a similar plastic operation must be performed for their relief. When a recto-vaginal fistula is the consequence of malignant disease of the rectum, the operation of colotomy is often the means of affording great relief to the patient.

Vaginitis (Kolpitis).—Acute vaginitis may arise from several causes, of which undoubtedly gonorrhœa is the most common; it may arise also from injury, the introduction of foreign bodies, the use of too irritating injections, and from exposure to cold. It may also occur in children as a sequel to the exanthemata.

Symptoms.—The symptoms are a copious muco-purulent discharge, pain, and discomfort, especially severe on micturition, when the pain is of a scalding character, or during defæcation or connection. Upon examination the mucous membrane is found to be swollen, red and injected, and to be very tender to the touch. Occasionally patches of superficial ulceration may be seen upon it. In severe cases the inflammation may extend to the uterus (endometritis), and thence to the Fallopian tubes (salpingitis).

Treatment.—The patient should be confined strictly to bed, on a light diet, without stimulants. The bowels should be kept freely acting with saline aperients, and the vagina frequently douched with hot Condy's fluid (ʒj to Oj). A hot bath often affords considerable relief, and may be repeated every night. When the more active symptoms have subsided, astringent injections—acetate of lead or sulphate of zinc—should be used, and a pledget of lint, soaked in glycerole of tannin, introduced into the vagina.

Leucorrhœa.—By the term *leucorrhœa* is meant a muco-purulent discharge from the vagina. It is popularly known as *the whites*. It may arise from many causes. It may be simply due to a catarrhal condition of the mucous membrane of the vagina and cervical canal in females who are the subjects of debility and anæmia, but it is also undoubtedly not infrequently the sequel of an acute attack of vaginitis, especially when it is of the gonorrhœal form. It is also of constant occurrence in prostitutes and others in whom there is constant excitement of the generative organs. The disease is characterised by the discharge of a glairy mucous, or muco-purulent, discharge from the vagina, without any other symptoms, except that it is often attended, especially in the debilitated, by aching pain in the lower part of the back. It is often impossible to distinguish the disease from the gleety stage of gonorrhœa, more especially as, in its aggravated form, it may give rise to urethritis in the male.

The **treatment** consists in repeated douching with some mild astringent lotion and in absolute cleanliness; in improving the general health by tonics, careful dieting, regular gentle exercise, and in keeping the bowels freely open.

Leucorrhœa in children.—There is a special form of leucorrhœa in children which requires mention, as it is liable to be mistaken by the mother and others for gonorrhœa. It usually occurs in children of a tuberculous type and appears to be excited very often by want of attention to cleanliness, but also as a sequel to the eruptive fevers, or during dentition. The labia become swollen and red, and the parts are painful and tender; the child cries out when it passes its water, and walks with difficulty and with a straddling gait, keeping its thighs well apart. There is an abundant purulent, or muco-purulent, discharge.

The **treatment** consists in strict cleanliness and frequent douching of the parts with a weak antiseptic lotion (boric acid, Condy, &c.). Between the douchings the parts should be protected by boric acid ointment spread on lint, a piece being inserted between the labia to keep them apart. The child should sit in a hot bath night and morning. The bowels must be kept freely open, the diet regulated, and cod-liver oil given internally.

Vaginismus.—This term is applied to a painful, uncontrollable spasm of the muscles about the orifice of the vagina when sexual congress is attempted. The spasm is so great, and is attended by so much pain, that sexual intercourse is rendered impossible.

Causes.—In many cases a cause for the condition may be found in the existence of a small fissure or ulcer on the vulva, or a urethral caruncle; in other cases it is due to an hyperæsthetic condition of the remains of the ruptured hymen, and from this cause is very common in newly married women. In many cases no obvious cause can be found.

In the **treatment** of this affection careful search must be made for any of the above-mentioned causes, and they must be dealt with. If an ulcer is present it must be touched with lunar caustic and all attempts at intercourse interdicted until it is healed. If a caruncle is present it should be removed; or if any remains of the hymen seem to be particularly sensitive, they should be excised. Occasionally piles may be present, and if so should be removed, as it is stated that they may give rise to this condition. If none of these causes are found, stretching of the parts under an anæsthetic will often effect a cure; or the local application of cocaine before an attempted coitus will sometimes deaden the sensibility so as to allow of its consummation, and after a time the condition of spasm will cease to occur as the parts become habituated to the act.

Tumours of the vagina are very rare. The only ones which require special mention are cysts, which may arise either from obstructed mucous follicles or from the persistent terminal end of Gartner's duct. They belong to the class of retention cysts and very seldom give any trouble or inconvenience, as they rarely attain a greater size than a hazel nut. They may generally be cured by excising a part of the wall of the cyst with scissors, and destroying the remainder with caustic. Small fibromatous and sarcomatous tumours are also stated to occur in the vagina, but they are very rare.

Squamous epithelioma occurs in the vagina, but it is almost always the result of an extension of the disease from the vulva or from the cervix; as a primary disease it is very rare, but not unknown. It presents the ordinary characters of epithelioma: an excavated ulcer, with indurated edges, which discharges a foul, and oftentimes bloody, matter. It is accompanied by much pain and early implication of the neighbouring lymphatic glands. It is only in the very early stage that complete removal can be attempted; later on the treatment must be simply palliative.

DISEASES OF THE UTERUS

The only affection of the uterus which it is necessary to consider in a treatise on General Surgery is tumours of that organ. Abnormal conditions of the cervix; endometritis and cervical endometritis, acute and chronic; and displacements of the uterus, require special treatment, and are discussed in works on Diseases of Women, to which the reader is referred.

Tumours of the uterus.—The uterus may be the seat of any of the following varieties of tumour: myoma, adenoma, sarcoma, and carcinoma.

1. **Myoma.**—The myoma (fibro-myoma), or, as it is popularly called, *fibroid tumour* of the uterus, is not only the most common form of uterine tumour, but is also one of the commonest tumours to which women are liable. Structurally they consist of unstriped muscular tissue and fibrous tissue in varying proportions. The excess of one or other tissue causes alterations in their consistence, so that it is customary to divide them into hard and soft fibroids. The *hard* fibro-myoma is much the more common of the two, and constitutes the ordinary fibroid. It contains a large proportion of fibrous tissue and is very hard. The fibres of which it is composed are arranged in a concentric manner, so as to give to the cut surface of the tumour the appearance of a whorl. These tumours are distinctly circumscribed, and are surrounded in the greater part of their extent by a capsule; but this capsule is deficient at one point, where the new growth is continuous with the uterine tissue. Their rate of growth is slow. The *soft* fibro-myoma or true myoma is rare. It contains but little fibrous tissue, and is made up almost entirely of long fusiform cells, with rod-like nuclei. It is very vascular, is not distinctly circumscribed, and grows very rapidly.

These tumours, composed of a greater or less amount of muscular tissue, are direct outgrowths from the muscular tissue of the uterus, and may originate in three different places. They may grow from the muscular tissue of the uterine wall, and are then termed *intra-mural*; or they may grow from the sub-serous tissue, which over the uterus consists largely of unstriped muscular fibre; these are the *sub-peritoneal* form of tumour; or lastly, they may grow from the muscle cells of the mucous lining of the uterus, constituting the *sub-mucous* form. This last form of tumour projects into the cavity of the uterus, and may be prolonged through the cervix and os into the vagina, when it resembles polypus. These will be considered later on. It must be borne in mind that an intra-mural myoma by its growth may project into the peritoneal or uterine cavities, and that it then constitutes a variety of sub-peritoneal or sub-mucous myoma, though it does not originate in quite the same position as the tumours bearing these names usually do. When myomata project either on the serous or mucous aspect of the uterus, they have a tendency to become pedunculated.

Uterine myomata usually appear between the ages of thirty-five and forty-five, and are most common in unmarried women, or in married women who have never been pregnant. They are very rarely found in women who have borne many children. From this it has been inferred that myomata arise as a consequence of the uterus not being called upon to exercise its normal function. That is to say, that the repeated congestion of the organ at each menstruation expends itself in an irregular permanent hypertrophy when not called upon to undergo the temporary hypertrophy attending pregnancy. In a large number of cases the disease gives rise to no symptoms which justify operative interference. At the menopause the hard fibro-myoma ceases to grow, and either dwindles or remains stationary, and in old age may undergo calcification. The soft tumours may, on the other hand, continue to grow after the menopause and cause great loss of blood. Uterine fibroids are frequently multiple, and in the same uterus sub-peritoneal, intramural, and sub-mucous growths may exist (fig. 397).

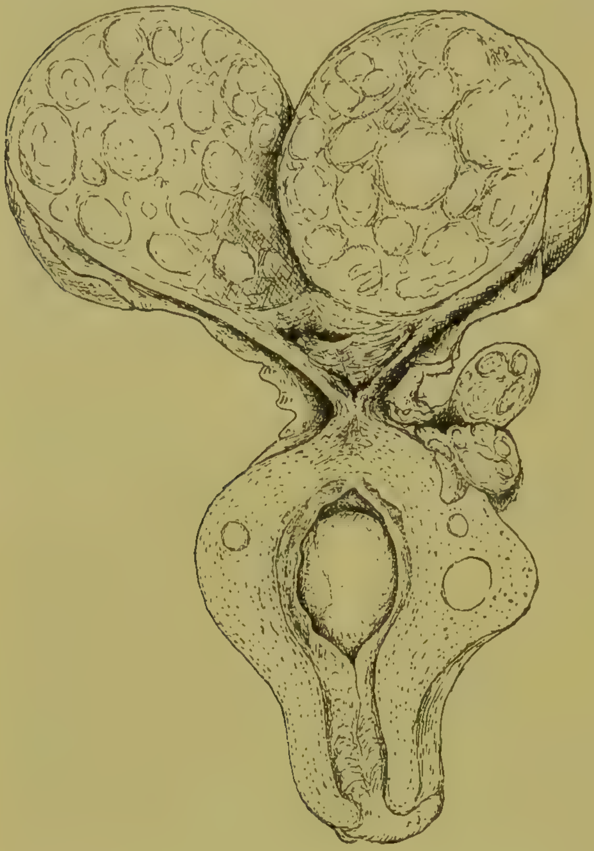

FIG. 397.—Uterus with numerous fibroid tumours; sub-peritoneal, intra-mural, and sub-mucous. (From the Museum of St. George's Hospital.)

Symptoms.—The main symptom of uterine fibroids is menorrhagia. It is also the earliest sign. The patient finds that she commences to lose more blood than formerly at each catamenial period, and that these periods are prolonged, lasting five, six, eight, or ten days; then that the intervals between the periods are shortened; so that at last she is scarcely ever free. This, combined with aching, weariness, and pain, often acute just before the commencement of a period, is often all, until on examination a pelvic tumour is discovered. This is usually situated in the hypogastric region after it has risen out of the pelvis, but may be found in the inguinal region or even the lumbar. It is firm, hard, rounded, and usually smooth, but may be tuberculated. It is distinctly circumscribed, and dull on percussion. Occasionally in a rapidly growing tumour a distinct bruit may be heard. Upon bimanual examination its continuity with the uterus can be made out, and by the introduction of a sound the position of the uterus in relation to the tumour can be ascertained. In the earlier stages, before the tumour can be felt externally, it will generally be found that the cavity of the uterus is enlarged, as indicated by the sound, and this will be strong evidence of the presence of a fibroid tumour. Another symptom which is often present in these cases is incontinence of urine; either from the pressure of the tumour on the bladder or from dragging on its neck, when the growth is on the anterior wall of the uterus. The constitutional effects are mainly due to the loss of blood, which may be sufficient to cause death directly, or induce it from the anæmia it sets up. Death may also be caused by pressure on neighbouring viscera; on the rectum, leading to obstruction;

on the ureters, leading to dilated kidneys, or on the urethra, leading to retention, cystitis and pyelo-nephritis.

Complications.—Fibroid tumour of the uterus may be complicated by (1) pregnancy, when abortion frequently takes place, and, owing to the condition of the uterus, contraction does not easily follow; hence, retention of clots or membranes is likely to occur and consequent septic poisoning. If the patient goes the full time, the tumour may form an insurmountable obstacle to delivery, requiring Cæsarean section. (2) Impaction is another complication which may arise. The tumour becomes firmly wedged in the pelvis, from which it cannot rise, or, indeed, from which it cannot be dislodged. (3) Finally, gangrene may occur in cases of large submucous fibroids, which protrude into the vagina, and this may cause death from septicæmia or septic peritonitis.

Treatment.—In a large majority of cases uterine fibroids give rise to no serious symptoms, and in these cases no operative interference is required because the disease is not fatal, and in all probability at the menopause the tumour will cease to grow and may possibly shrink and perhaps disappear altogether, or undergo calcareous degeneration (fig. 398). But there are other cases in which on account of severe, persistent, and uncontrollable hæmorrhage, or from the rapid growth of the tumour, or from the pain and pressure effects which it produces, operative interference becomes necessary. The treatment must vary according to the situation and variety of the tumour. In cases of sub-peritoneal fibroids which are pedunculated the procedure is a comparatively simple one. The abdomen is opened in the middle line, and the tumour delivered through the opening. The pedicle is then transfixed with a blunt needle and tied in two halves, one of the ligatures being afterwards made to encircle the whole pedicle and again tied. The tumour is now separated by division of the pedicle on the distal side of the ligature and the cut edges of the peritoneum are sutured together with a fine silk or catgut suture over the face of the stump. The external wound is then closed. This operation is only of service when there is a single fibroid. In cases of single sub-peritoneal tumours which are sessile and partially embedded in the uterine wall, it has been proposed to cut away the tumour and a wedge-shaped

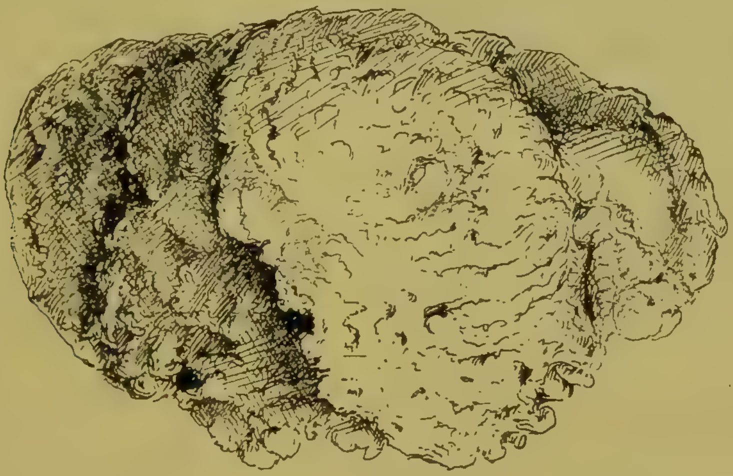

FIG. 398.—Calcareous degeneration of a large fibroid tumour of the uterus. (From the Museum of St. George's Hospital.)

piece of the wall of the uterus and then accurately suture the two cut surfaces together and finally unite the cut edges of the peritoneum over the deep sutures. The operation is not, however, to be recommended. There is great difficulty in uniting the cut surfaces of the uterine wall, as the uterine muscular tissue does not lend itself readily to accurate suturing. It is better, therefore, to treat these cases in the same way as other growths which are completely embedded in the uterine wall.

In cases of intra-mural growths which are presenting at and have distended the external os, an attempt may be made to remove the tumour by enucleation. In this operation the capsule is divided with a knife, and then the tumour is separated from the uterine wall with the finger or an elevator, being at the same time dragged down by a volsellum, with which it is seized. In this way it is gradually enucleated. The cavity is then plugged with sponges or pledgets of wool soaked in tincture of iodine, and the vagina is constantly syringed with antiseptic solutions. The operation is a difficult and tedious one, and is often attended by a very considerable loss of blood.

With the exception of these cases of single fibroids either sub-peritoneal and pedunculated or sub-mucous and presenting at the external os—that is to say, in the great majority of cases—some other mode of operation will have to be adopted.

There are two ways in which these cases may be treated, by Oöphorectomy and Hysterectomy.

Oöphorectomy, or removal of the uterine appendages, is based on the fact that in most cases uterine fibroids cease to grow and very often dwindle when the menopause sets in; it is argued therefore that by removing the uterine appendages an artificial menopause may be established, and decrease in the size of the tumour and a cessation of the flooding take place. If this were proved to be the fact by actual experience, there is no doubt that it would be a strong argument in favour of this operation, which is attended with very little risk. But experience has shown that this operation is not to be relied upon, and that though in some cases it has been followed by a diminution of the growth and an arrest of the menorrhagia, in others no such decrease has taken place, but that the tumour has gone on growing, especially in the case of the soft fibroids, which are the ones in which there is usually the greatest loss of blood.

Moreover, the removal of both ovaries is an operation to be deprecated. There is no doubt that the ovaries, like the testicles in the male, are in some way, which is not at present very well understood, necessary for the well-being of the individual, and that their removal is attended with an interference with the general equilibrium ; just as much as the removal of the thyroid gland produces marked signs of derangement of the general health. The operation of oöphorectomy is likely in the future to fall more and more into disuse.

The operation of oöphorectomy is performed as follows : The abdominal cavity is opened by a median incision, as low down as possible without injuring the bladder, and the fingers passed into the abdomen and the ovary and tube felt for, and when found seized and drawn into view. When this has been done they are caught, as shown in fig. 399, by a pair of large elbow forceps A needle, armed with a silk ligature, is passed through the broad ligament immediately below the forceps : the ligature is retained while the needle is withdrawn, leaving a loop of silk on one aspect of the broad ligament and two free ends on the other. The loop is divided, and two of the free ends are now tied on the inner border of the ligament, and the other two on the outer. One pair of ends are cut off short, the other are made to encircle the whole pedicle, and again tied, and then cut off short. The same proceeding is repeated on the other side. While the ligatures are being tied the forceps should be removed, the ovary and tube being held by an assistant, so that the knot may be tied as tightly as possible. The broad ligament, with the Fallopian tube and the ligament of the ovary, is now divided with scissors external to the encircling ligature and removed. The pedicles must be examined to see that they are perfectly dry, the peritoneal cavity sponged out if necessary, and the external wound closed.

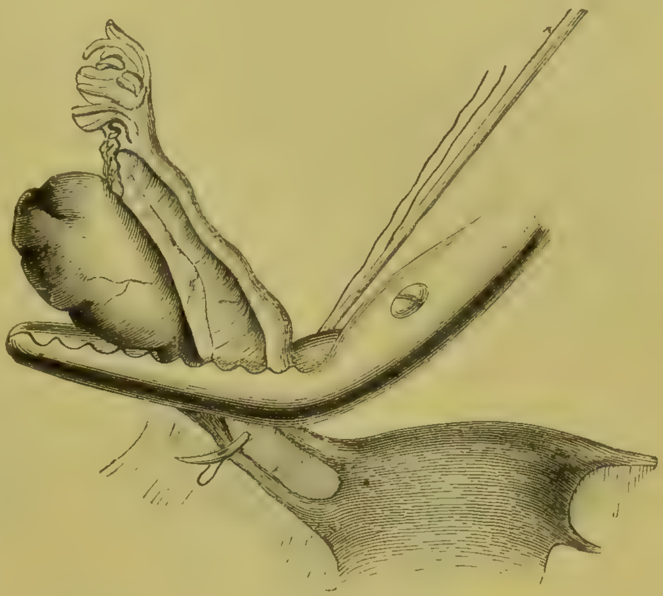

FIG. 399.—Mode of grasping the appendages and inserting the needle in oöphorectomy. (After Doran.) (From 'Operations of Surgery,' by Jacobson.)

Hysterectomy.—Three different operations have been performed for removal of the uterus in cases of uterine fibroids. (1) Supra-vaginal hysterectomy, where the main bulk of the uterus is cut away and the stump, consisting of the cervix, encircled by a wire constrictor, is brought outside the abdominal wall and fixed there, and allowed to separate. (2) Supra-vaginal hysterectomy, where the uterine and ovarian arteries are secured separately, and the stump, consisting of the cervix, is returned, the peritoneal edges being sutured over it, so as to avoid, if possible, septic infection through the cervical canal, which has been cut across. Neither of these operations is completely satisfactory. In the first the pedicle becomes adherent to the abdominal wall; there is the prolonged period of separation of the stump with its consequent dangers, and the abdominal cicatrix is not so firm as one resulting from immediate union. In the second there is always the danger of septic inflammation of the peritoneum through the cervix, which allows of a communication between the vagina and the under surface of the peritoneum, which is sutured over the end of the stump. It seems probable that in the future these two operations will be entirely superseded by (3) pan-hysterectomy, or removal of the whole of the uterus. This operation, which is comparatively new, has already yielded the most satisfactory results. It will be sufficient if we describe this third operation, which, though more difficult of performance, is the one which should be selected, and which is performed as follows: For some days prior to the operation the external genitals must be thoroughly cleansed, and the vagina frequently syringed out with a solution of corrosive sublimate, and plugged with iodoform wool. An hour or two before the operation the lower bowel should be emptied by a copious enema. The abdomen having been cleansed and the pubes shaved, the patient is anæsthetised and the abdomen opened in the usual way by a median incision, which is carried down to the symphysis pubis, or nearly so. When the peritoneum has been incised the intestines are pushed to the upper part of the abdomen and held there, out of the way, by hot towels or flat sponges. The uterus is then seized with a strong volsellum and pulled over to one side while the ovarian and uterine arteries are secured. This is done by three ligatures, which are made to transfix the broad ligament close to the uterus, and are looped over each other so that they interlock. The first one secures the Fallopian tube and the ovarian vessels, the second one secures the round ligament and the pampiniform plexus, and the third one, which is inserted but not yet tied, is intended to secure the uterine artery. The accompanying figure (fig. 400) shows the relative position of these structures. The upper part of the broad ligament, with the Fallopian tube and round ligament, is now divided on the uterine side of the ligatures as low as the lower level of the second ligature, and the process repeated on the other side. It will then be found that the uterus can be raised out of the pelvis. A transverse incision is now made through the peritoneum, where it is reflected from the anterior surface of the uterus on to the back of the bladder, and the peritoneum is peeled from the surface of the uterus until the vagina is reached, and the anterior wall of this tube is cut across. The uterus is now turned forwards and the peritoneum at the bottom of Douglas's pouch incised transversely, and the posterior wall of the vagina divided across until it meets the incision on the anterior wall. The uterus is now almost free, and is held only by the lower part of the broad ligament on either side, containing the uterine artery. The third ligature, which was passed through the broad ligament, and interlocked with the second, is now made to encircle all this tissue by passing one end behind it into the vagina and bringing it up in front, and the ligature is then tied, thus constricting the uterine artery. The tissues are divided between the ligature and the side of the uterus.

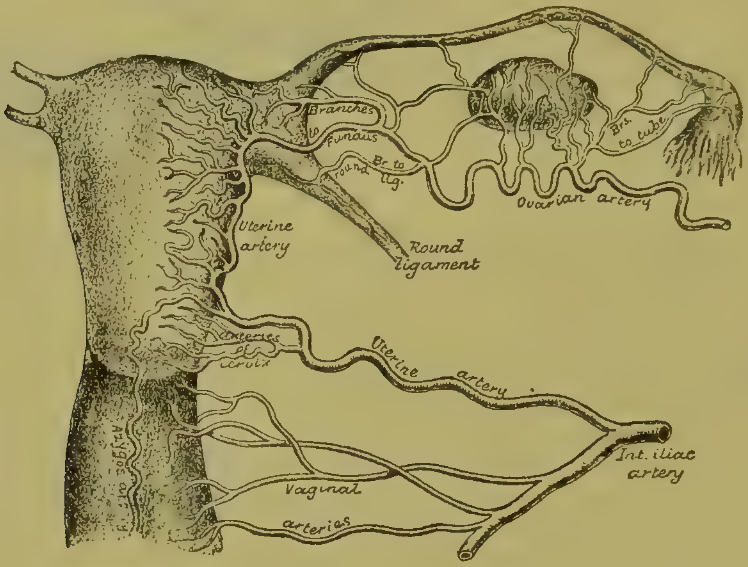

FIG. 400.—The vessels of the uterus and ovary, showing their relative positions. (From Gray's 'Anatomy.')

The organ is now free, and can be removed. The parts are then well irrigated with antiseptic solution, so as to get rid of all blood clot; the vagina is plugged with antiseptic gauze, and the external wound closed in the usual way. The vagina acts as a drain, and therefore the opening into it is not sutured. The gauze plug is removed at the end of forty-eight hours.

Some surgeons recommend the removal of the whole of the uterus, with its fibroids, per vaginam, in the same manner as the cancerous uterus is removed by what is termed vaginal hysterectomy. But if the fibroid tumour is large, as it very often is, its size acts as a barrier to its safe delivery through the pelvis and genital passages; and under these circumstances it may be necessary to cut it into pieces before it can be removed, and this seriously complicates matters, more especially as it is necessary to secure the vessels in the first instance, and this is often difficult with a large tumour.

2. **Adenomata.**—These tumours of the uterus are not of much importance. They are composed of glandular structure embedded in an abundant fibrous stroma. The type of gland structure varies with the situation of the tumour. For the most part they grow from one of the lips of the cervix uteri, but also occasionally from the mucous lining of the cavity of the uterus. They never attain any large size, and constitute one of the forms of uterine polypi.

Polypi.—Polypi of the uterus are of two varieties.

a. The **adenoma**, the tumour just alluded to, which usually grows from the cervical canal, never attains a greater size than a hazel nut, but may cause a good deal of inconvenience from hæmorrhage and leucorrhœa. They are at once to be felt on digital examination, and may be either pedunculated or sessile. In most instances they can be removed by seizing them with a pair of torsion forceps and twisting them off, but when they are more sessile they may require removal with scissors. After removal a strong solution of iodine should be applied to prevent septic mischief.

b. **Myoma** or **fibromyoma.**—This is the ordinary uterine polypus, which, growing from the walls of the cervical canal or uterus, projects at the os as a pear-shaped tumour with a distinct pedicle or stalk (fig. 401). They may attain a considerable size, as large as a man's fist, and, though not very vascular, may give rise to alarming and even dangerous hæmorrhage. They can easily be felt on digital examination, with a narrow stalk attached to or projecting from the os, and can be removed without difficulty by means of the wire écraseur, the wire being slipped over the polyp, so as to be made to embrace the pedicle, and then slowly tightened until the pedicle is cut through. It is

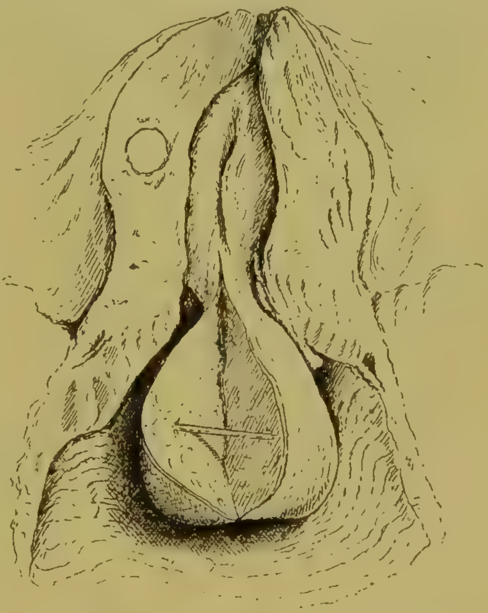

FIG. 401.—Polypus of the uterus. (From the Museum of St. George's Hospital.)

important to bear in mind that an intra-mural myoma may distend the uterine cavity, and then after dilating the os may descend into the vagina and may resemble a polypus. These tumours are often of much larger size and may become gangrenous. Under these circumstances they will have to be removed, and in order to do this, when they are large, it may be necessary to cut them away piecemeal with scissors. If the tumour is gangrenous, the hæmorrhage is not great, but dangerous septicæmia will in all probability be present, and the life of the patient is in considerable peril.

3. **Sarcoma** is a very rare disease of the uterus, and very little is known about it. Occasionally a form of polypus is found growing from the uterine cervix which partakes of a sarcomatous nature, consisting of spindle-shaped cells, mixed with glandular structure, and probably being an adeno-sarcoma. It has a tendency to recur if removed.

4. **Carcinoma.**—Carcinoma of the uterus occurs in two forms: (*a*) Columnar carcinoma; (*b*) Squamous carcinoma or epithelioma.

a. **Columnar carcinoma** may commence either in the cervical tissues or in the body of the uterus. The two conditions will have to be considered separately, as they differ considerably in many details and in their treatment. Columnar carcinoma of the cervix is very much more common than the same disease in the body of the uterus. It occurs in younger women, generally between the ages of thirty-five and fifty, and rarely appears after the menopause. It is more common in women who have borne children. The disease begins in the glandular structure of the cervical canal, most commonly in the lower half, as a nodule in the wall of the cervix. This nodule grows and infiltrates neighbouring parts; it spreads laterally into the broad ligaments, and the uterus becomes fixed: it spreads backwards and forwards into the recto-vaginal and vesico-uterine septa and upwards into the body of the uterus, which in the later stage may become an excavated cavity from ulceration of the growth. The recto-vaginal and vesico-uterine septa may be perforated, and fistulous communications formed with the rectum and bladder. The patient generally dies of exhaustion, but may succumb to peritonitis, from perforation of the body of the uterus, or from pyelo-nephritis, from septic inflammation spreading up the ureters in cases where the bladder is involved.

The **symptoms** of cancer of the cervix are hæmorrhage, pain, and offensive discharge. Hæmorrhage is usually the first sign, and is followed by a fœtid discharge as soon as ulceration has taken place. Pain is not usually an early symptom, but in the later stages of the disease is very severe. The presence of bleeding, coming on at irregular intervals and accompanied by an offensive blood-stained discharge, should always induce the surgeon to make a vaginal examination, when, if cancer be present, the cervical tissues will be felt to be enlarged, hard, and nodular, and on examination with the speculum the os will be found patulous, with a fungus-like protrusion from it. Later on the cervical tissues will be found to have entirely disappeared and to be replaced by a foul, ulcerating cavity, with indurated edges and base.

Treatment.—The treatment of this form of the disease must depend upon the stage in which it is when first discovered. When the disease is strictly limited to the lower portion of the cervix, amputation of the vaginal segment may perhaps be all that is necessary. But the cases are rare in which the disease is met with in this early stage, and the operation in itself is not satisfactory, as it is usually followed by speedy recurrence. The operation of supra-vaginal amputation is therefore usually necessary, or, if may be, total extirpation of the uterus. In those cases where the disease has spread to adjoining tissues, and the uterus is more or less fixed, no operation aiming at the radical removal of the disease is admissible, but a vigorous scraping of the diseased structures, and a removal of the growth as far as possible, may be of service in checking the hæmorrhage and getting rid of the fœtid discharge for a time, and in this way giving comfort to and prolonging the life of the patient.

Columnar carcinoma of the body of the uterus is not nearly so common as of the cervix. It usually occurs in older women, after the cessation of the catamenia, and particularly in women who have never borne children. It commences in the tubular glands of the mucous membrane of the uterine cavity, and infiltrates the walls of the uterus, but, as a rule, does not implicate the cervix till a late period of the disease, so that on vaginal examination the os and cervix feel healthy. The symptoms are hæmorrhage, offensive discharge, and pain ; and when a woman, after the menopause, complains of irregular attacks of hæmorrhage, with offensive blood-stained discharge, cancer of the body of the uterus should always be suspected, especially if the uterus is felt to be somewhat enlarged. The only way, however, in which an accurate diagnosis can be made is by dilating the os and scraping the internal surface of the cavity of the uterus, and examining microscopically the débris brought away.

Treatment.—The only curative treatment for this condition is removal of the whole uterus, and this should only be done in those cases where the surgeon can satisfy himself that the uterus is freely movable and that therefore there is no implication of surrounding structures.

b. **Squamous epithelioma.**—This is a form of carcinoma which exactly resembles epithelioma in other parts of the body. It commences in the epithelial cells of the mucous covering of the vaginal surface of the cervix, and from this tends to spread downwards on to the vaginal wall. It also spreads outwards to the tissues of the broad ligament, but rarely invades the cervix. It may spread through the vaginal wall into the bladder in front or the rectum behind and give rise to fistulous communications.

The **symptoms** are very much the same as those of cancer of the cervix, hæmorrhage and offensive discharge, but there is little pain in the earlier stages of the disease. To these may be superadded bladder symptoms, increased frequency of micturition, &c., when the anterior wall of the vagina becomes involved. Upon examination with a speculum a foul, ulcerated surface, with raised and everted edges, may be seen, with sometimes an irregular papillomatous, cauliflower-like growth.

Treatment.—When the disease is still limited to the vaginal portion of the cervix, and has not implicated the vaginal wall or spread to the broad ligaments, causing fixation of the uterus, supra-vaginal amputation of the cervix should be at once resorted to and may do much to prolong life.

Supra-vaginal amputation of the cervix is an operation which of late years has fallen to a certain extent into disuse. Until recently it was always advocated in cases of cancer of the uterus commencing in the neck, mainly because the operation could be performed without opening the peritoneal cavity ; now it is believed that total extirpation of the uterus is a better operation, as far as regards the chances of recurrence, and it seems probable that supra-vaginal amputation will in the near future be superseded by this operation in all cases except perhaps those of squamous epithelioma, where amputation of the cervix is all that is necessary, where the disease is seen and recognised before it has invaded the walls of the vagina or the neighbouring broad ligaments. The operation consists in removing a wedge-shaped piece of the uterus, including the cervix, through the vagina, and attaching the cut surfaces of the stump to the anterior and posterior vaginal walls, so as to prevent retraction.

The uterus may be removed for cancer either through the abdomen, in the same manner as is done in cases of fibroid tumours, or per vaginam (vaginal hysterectomy). The latter operation is, however, the better of the two, and is attended by a much smaller death rate.

Vaginal hysterectomy.—The vagina is rendered as aseptic as possible by douching for a day or two previously with solution of corrosive sublimate and plugging with iodoform wool. The rectum and bladder are emptied just before the operation. The patient having been anæsthetised is placed in the lithotomy position, with the pelvis well raised and in a good light. A large duck-bill speculum is introduced into the vagina posteriorly and held by an assistant. The cervix is then seized by a strong pair of volsellum forceps and pulled downwards and forwards so as to expose the posterior fornix of the vagina, and the mucous membrane divided by scissors as near the cervix as is possible without encroaching on diseased structures. By altering the position of the hand holding the volsellum, the sides and front of the cervix are successively brought into view, and the mucous membrane reflected from the cervix on to the vagina divided. In cutting at the sides and in front, the incision in the mucous membrane should never be more than three-quarters of an inch from the cervix, for fear of injuring the ureters. As soon as the mucous membrane has been incised all round, the cervix is again pulled forwards and the point of the scissors pushed through into Douglas's pouch. The scissors are then opened and withdrawn, making an aperture sufficiently large to admit a finger. Through this opening a finger is introduced into the peritoneal cavity, and as soon as the smooth surface of the serous membrane is felt, the forefinger of the other hand is introduced by the side of the first finger, and the opening dilated laterally as far as the sacro-uterine ligaments. A somewhat similar proceeding is adopted in front. but here the bladder has to be separated from the anterior wall of the uterus. This is done by gently burrowing upwards with the finger or a director for about an inch, taking care to keep close to the uterine wall, for fear of injuring the bladder, until the vesico-uterine fold of peritoneum is reached. An opening is to be made in this in the same way and the opening dilated with the two fingers. The uterus now remains attached to the wall of the pelvis by the broad ligaments only. These have to be dealt with, and in them, it must be remembered, are contained the blood-vessels supplying the uterus (see fig. 400). The forefinger of the left hand is introduced into the anterior peritoneal opening and an aneurism needle, armed with a long silk ligature, is introduced into the posterior opening, and, guided by the finger, is pushed through the broad ligament about an inch above its lower level and some little distance from the side of the uterus. The loop of the ligature is seized and held while the needle is withdrawn. One end of the ligature is now pulled through, so that we have the lowest inch of the broad ligament, in which the uterine artery lies, enclosed in a ligature. This is tightly tied so as to constrict the vessel. The same thing is done on the opposite side, and the broad ligament is then divided with scissors on either side, between the uterus and the ligature, to the extent to which the ligature extends. The uterus can now be drawn down considerably lower into the vagina, and a second inch of the broad ligament is treated in the same way. This second ligature will embrace the round ligament and the pampiniform plexus of veins, and when this second part, which has been constricted, has been cut away from the uterus, it will be found possible to drag the organ down sufficiently to pass a ligature over the top of the Fallopian tube, and by tying it constrict this structure and the ovarian artery. The tissues between this third ligature and the uterus are then divided with the scissors on either side, and the organ, being freed from all its connections, can be delivered from the vagina. The vagina is then washed out and lightly stuffed with gauze, no sutures being introduced. The gauze may be removed at the end of the second day.

The operation of removal of the uterus for cancer has not been attended with that amount of success which could be wished, because, in many cases, the connective tissue and glands of the pelvis are infected at a very early period of the disease and before operative interference has been undertaken, so that the removal of the uterus has proved merely palliative. Quite recently Ries and Clarke in America have advocated a much more extensive proceeding. They advise the removal, by the abdominal route, of the whole of the pelvic connective tissue, together with the uterus. The parts removed include all the lymphatic glands situated along the course of the iliac vessels up to the bifurcation of the aorta and in the sacral hollow, and the broad ligaments, utero-vesical and recto-vaginal ligaments, and the meso-rectum. The peritoneum is closed over the cavity that is left.

AFFECTIONS OF THE FALLOPIAN TUBES

The Fallopian tube is subject to several morbid conditions, which can scarcely be discussed in this work. It may be the seat of inflammation, either acute or chronic, generally the consequence of septic infection of the genital tract (salpingitis), or the closed tube may be the seat of dropsy as a result of inflammation (hydro-salpinx), or may be distended with pus (pyo-salpinx) or with blood (hæmato-salpinx), the blood being either the menstrual fluid which is unable to escape on account of an imperforate hymen, or atresia of the vagina, or blood which has been poured out into the tube as the result of injury or abortion. It must not be mistaken for a tubal gestation. The Fallopian tube may be the seat of stenosis, of tuberculous disease or of tumours, or its extremity may be herniated into a hernial sac in either the femoral or inguinal region, either alone or in company with the ovary, or with bowel or omentum. Finally, the Fallopian tube may be the seat of an extra-uterine fœtation, and it seems desirable that something more than a passing mention should be made of this condition, since the surgeon might at any time be called upon to operate on one of these cases, and it is necessary therefore that he should have a knowledge of the symptoms by which it may be recognised and the line of treatment which should be carried out.

Tubal pregnancy.—A fertilised ovum may lodge in any part of the tube. (1) When it lodges in that portion which traverses the wall of the uterus it is termed *interstitial* or *tubo-uterine gestation.* In these cases, when rupture takes place, it generally does so into the uterine cavity, and the embryo is discharged as in an ordinary abortion.

These cases, therefore, present no features of surgical interest. Rupture may, however, occur into the peritoneal cavity, and the case is then rapidly fatal. (2) A more common place for the ovum to be arrested is in some part of the outer two-thirds of the tube. This is *tubal gestation*, and is said to occur more frequently in the left tube. In these cases the fertilised ovum may be extruded through the ostium abdominale of the tube into the peritoneal cavity up to about the eighth week after impregnation, at which time the ostium becomes closed. If this does not take place and pregnancy advances, rupture of the tube is certain to occur, generally between the sixth and tenth week. (3) Sometimes the ovum is caught in the fimbriæ of the tube, and this is termed *tubo-ovarian gestation*. In these cases a sac may be formed partly by the dilated mouth of the tube and partly by adhesions around, and the patient may go on to the full period. (4) In some cases where rupture takes place and the patient survives, the embryo which has escaped from the tube becomes enclosed in a sac or cavity formed by adhesions; but the placenta still remaining attached to the tube, the embryo may go on living and the pregnancy may go to the full term. Or, on the other hand, secondary rupture—that is to say, rupture of the newly formed sac—may take place, or after a time death of the fœtus may ensue from the functions of the placenta becoming impaired. This class of cases is spoken of as *abdominal gestation*.

In cases which go to the full period spurious pains come on at its close, which continue for some time and then disappear; the child dies, and may become mummified and quiescent and cause no further trouble; or inflammation may be set up in the sac and lead to general peritonitis and death; or the sac may suppurate and an abscess form which may open on to the abdominal wall, or into the rectum, bladder, or vagina, and the remains of the fœtus may be discharged.

Symptoms.—In describing the symptoms, we must describe those by which a tubal pregnancy may be recognised before rupture has taken place, and then those which occur at the time of rupture. The physical signs of tubal gestation before rupture are very much those of a tubal dropsy or a small ovarian tumour; but when in addition to this we have the signs of pregnancy, a cessation of the catamenia, morning sickness, and perhaps a fullness of the breasts, there is a strong inference that tubal gestation is present. But opportunities of meeting with such cases are not common, since the condition causes no trouble, and the patient's attention is not in any way drawn to it until rupture takes place. She may or may not believe herself to be pregnant. When the rupture takes place, which may be during some muscular exertion, as straining at stool, or lifting a weight, &c., or may occur quite independently of any muscular effort, the patient experiences a sudden pain in the lower part of the abdomen, as if something had given way. This is at once followed by severe shock, with evidences of loss of blood, pallor, and blanching of the lips, faintness, jactitations and restlessness, a subnormal temperature, and a quick, weak, fluttering pulse. Accompanying these symptoms there is pain at the seat of rupture, and perhaps an area of dullness on percussion.

The patient may and frequently does die in the course of a few hours. Should she survive, blood may flow from the vagina.

Treatment.—In cases where a diagnosis of tubal gestation has been made before rupture has taken place, an abdominal section should be performed, and the gravid tube removed to save the patient from the dangers which attend rupture. In the majority of cases, however, the rupture will have taken place before the surgeon will be called upon to treat the patient. These cases imperatively call for immediate operation. An abdominal section should be at once performed, and the tube, with its placenta and embryo and the ovary and part of the broad ligament, should be removed in the same manner as in oöphorectomy; the peritoneal cavity should be then cleared of blood and clots and the external wound closed. This can only be done in cases of tubal gestation where rupture occurs, as it almost always does, before the tenth or twelfth week. In cases of tubo-ovarian gestation where the rupture may take place later, or in cases of secondary rupture, this cannot be done. The sac must be laid freely open, the fœtus extracted, and the sac wall sutured to the edges of the abdominal wound. The placenta must not be disturbed. The strictest antiseptic precautions must be taken.

AFFECTIONS OF THE OVARY

Malpositions of the ovary.—The ovary may be misplaced or displaced. It is *misplaced* when it does not descend to its normal position after its development in the lumbar region; it may be retained either in the neighbourhood of the kidney, or it may descend as far as the brim of the true pelvis, and become fixed in this position. The ovary may be *displaced* either into the sac of a hernia (*oöphorocele*), or into Douglas's pouch (*prolapse*).

Oöphorocele or **hernia of the ovary.**—In these cases the ovary becomes displaced, and passing out of the pelvis through the inguinal canal or the femoral ring, and, pushing the peritoneum before it, forms a complete hernia, in which the contents of the sac is the ovary, sometimes accompanied by the fimbriated extremity of the Fallopian tube (page 1063). The variety of hernia is most frequently inguinal, and it may occur on one or both sides. In some cases the hernia, when inguinal, is said to be of the congenital variety, and the ovary would then descend through the canal of Nuck into the tunica vaginalis. There are no very distinct signs by which this form of hernia can be diagnosed from an ordinary intestinal hernia, but it is said that it becomes larger and more tender during menstruation; there is, of course, no characteristic gurgle on reduction. Sometimes the ovary in the sac may become inflamed, and symptoms would then arise which might simulate strangulation, or true strangulation may occur, though this is rare.

Treatment.—In the majority of cases where the ovary is reducible the condition may not be suspected, and the case may be regarded as an ordinary hernia. If it is, the treatment would be the same: the application of a well-fitting truss. It may be sometimes necessary, on account of great pain, or from degenerative changes taking place in the ovary, to remove it.

Prolapse of ovary.—As a result of some displacement of the uterus, or in consequence of some change in the bulk of the ovary and after pregnancy, the ovary may become displaced into Douglas's pouch and lie between the rectum and vagina. It may then give rise to no symptoms at all, or, on the other hand, it may be the source of great pain and discomfort. The patient often suffers from a constant, wearing, sickening pain in the region of the sacrum, greatly increased at the catamenial period. Increased pain is also felt during defæcation, especially if the bowels are at all constipated, from the pressure of the hardened fæces on the ovary. It can usually be felt as a firm, rounded body through the vagina, and the pressure of the finger on the swelling often causes a sickening pain. The tumour may be movable or fixed by adhesions. If it is movable, it can generally be pushed out of the pouch, and be prevented from returning by a suitable pessary. If it is fixed and the cause of great pain and suffering, it may be necessary to remove it by abdominal section, after milder means, such as rest, sedatives, and aperients, have failed to relieve.

Oöphoritis.—Inflammation of the ovary, either acute or chronic, is usually associated with salpingitis, and is a part of that disease, except in those cases to which allusion has already been made, in which it is a sequel to mumps (page 731). The ovary is sometimes the seat of tuberculous disease, rarely as a primary affection, but not uncommonly following tuberculous disease of the Fallopian tube, or occurring in cases of tuberculous peritonitis.

Tumours of the ovary.—Tumours of the ovary may be divided for the purpose of description into solid and cystic tumours. The latter, from the greater frequency with which they are found, require the first and the most careful consideration of the student.

Cystic tumours of the ovary.—Under the class of cystic tumours of the ovary are included cystic tumours starting from every part of the tubo-ovarian apparatus, for from a practical point of view it is impossible to separate cysts starting from the region of the ovary from those which commence in the ovary proper.

It will be convenient to classify ovarian cysts in the following manner: (1) Multilocular cystic tumours, or proliferating glandular cysts; (2) papillomatous cysts, or proliferating papillary cysts; (3) dermoid cysts; and (4) parovarian cysts. It must be mentioned, however, that there are several other forms of cysts found in the tubo-ovarian apparatus, which never attain a large size, and have no clinical importance, and therefore require no further mention; such are cysts of the corpora lutea, follicular cysts or dropsy of the Graafian vesicles, and residual cysts arising from the hydatid of Morgagni.

1. The **multilocular cystic tumour** or **proliferating glandular cyst.**—This is the most common of all ovarian cysts; it often attains a large size, and may affect both ovaries, one usually vastly preponderating in size over the other. In shape it is generally spherical or ovoid, irregular on its surface with bossy projections. Some of these tumours are apparently, to the casual observer, unilocular, consisting of a single cyst, but on examination a number of secondary cavities will be found in the cyst wall. Usually there are one or two cysts of predominant size, with a number of smaller ones, the size of an orange or a plum, or even smaller. The walls of the cysts vary much in thickness, and consist of a fibrous envelope lined by a layer or layers of cylindrical epithelium, which in the larger cells may be flattened, probably from pressure. The fluid they contain varies in colour from a grey or apple-green to red or chocolate, the difference in tint being due to the presence of altered blood. It is glairy or syrupy, and feels more or less oily. It is albuminous, and plates of cholesterine may be found in it. Sometimes these tumours contain soft, succulent, semi-transparent masses of solid material, which microscopically consists of minute cavities or loculi, lined with columnar epithelium and filled with mucoid material, supported in a stroma of young

connective tissue. The mode of origin of these cysts has given rise to very considerable discussion, and it cannot be regarded as in any way settled. This question cannot be entered into here, and it will be sufficient to say that the germinating epithelium on the surface of the ovary, after it has dipped into the ovary to form the Graafian follicles, is probably the seat of origin of the cysts.

2. The **papillomatous** or **proliferating papillary cysts** differ from the preceding in that the cysts contain exuberant papillary growths (fig. 402). The connective tissue of their wall forms buds that project into the cystic cavity, pushing the epithelium in front of them, and divide into slender papilliform branches. These buds may completely fill the cavity, and cause its walls to give way; they then project on its surface, and appear like cauliflower masses, and may invade the peritoneum, and form disseminated papillary growths. They develop from the hilum of the ovary, and are often enclosed in the broad ligament, which they may afterwards perforate. The origin of these growths, like that of the proliferating glandular cysts, is uncertain. Some pathologists believe that their mode of origin is the same; others believe that they spring from some remains of the Wolffian body.

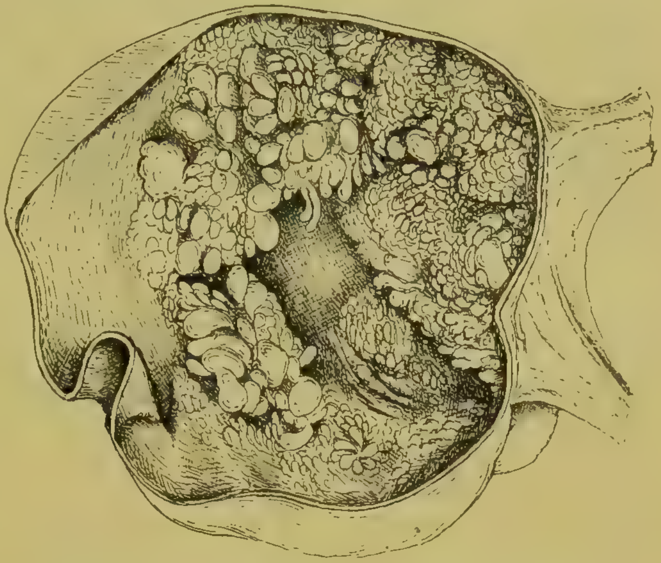

FIG. 402.—Papillomatous cyst of the ovary. (From the Museum of St. George's Hospital.)

3. **Dermoid cysts** (fig. 403) are generally small, and may for a long time remain latent, and, in fact, may not be suspected or discovered until post-mortem examination. They may, however, after a period of latency begin to increase in size, and may then attain great dimensions. Their inner surface is lined by a membrane which resembles skin in microscopic structure, and is separated from the fibrous envelope of the sac by fatty tissue. This layer presents papillæ, sebaceous and sweat glands, and hairs implanted in hair follicles, the hairs being sometimes two, three, or even more feet in length. The cysts are filled with fatty

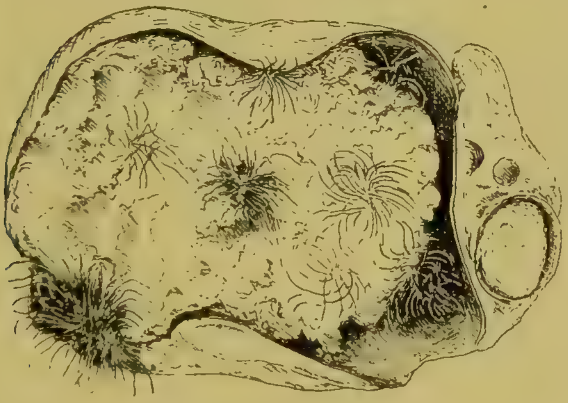

FIG. 403.—Dermoid cyst of the ovary. (From the Museum of St. George's Hospital.)

matter, containing epithelial cells, crystals of cholesterine, and fatty acids. Teeth, bones, horn, and nails are not infrequently found in these cysts; and more than one case has been recorded where a mammary gland has been discovered. The question of the origin of dermoid cysts of the ovary has long been the subject of controversy, and many theories have been brought forward at different times to explain their occurrence. The most probable explanation would appear to be the most simple one that the dermal structures contained in the cyst are developed from the epithelium lining the ovarian follicles, and that, unlike other dermoid tumours, they are not due to inclusion or incarceration of portions of the epiblast. The fact that ovarian dermoids are not found in an elementary condition in the ovaries of infants is confirmatory of this. The dermoid tumour of the ovary cannot be regarded as a congenital condition.

4. **Parovarian cysts.** — These cysts are, strictly speaking, not ovarian cysts, since they do not originate in the ovary, but in the broad ligament, in which they are enclosed, in close proximity to the organ of Rosenmüller, which lies between the ovary and the Fallopian tube. It is necessary to divide these cysts into two varieties, because there is a strong belief on the part of some pathologists that some of the cysts do not originate from the organ of Rosenmüller, and that others do. These two varieties may be distinguished as the *hyaline parovarian cyst*, or cyst of the broad ligament, as it is sometimes called, and the *papillary parovarian cyst.*

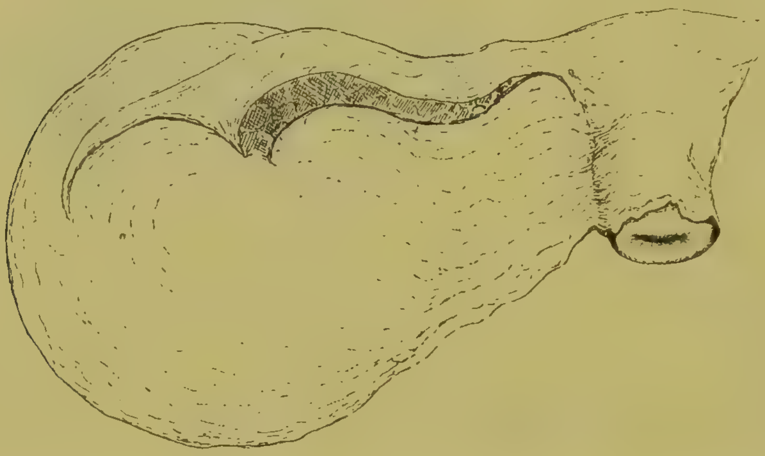

FIG. 404.—Hyaline parovarian cyst. (From the Museum of St. George's Hospital.)

The **hyaline parovarian cysts** (fig. 404) are unilocular, and it is very generally believed that they are simple, serous cysts, developed from the lacunæ of the connective tissue of the broad ligament; though others believe that they are due to an enlargement of the outer end of the horizontal tube of the parovarium. These cysts may attain a considerable size. Their cyst wall is very thin, and lined by cylindrical epithelium. Their contents is a thin, clear, watery fluid, of a low specific gravity, containing no albumen. They lie between the folds of the broad ligament, with which they are only loosely connected, and appear as rounded, translucent tumours with regular outline.

Papillary parovarian cysts.—These cysts are not so common as the preceding variety, and there seems to be a pretty general consensus of opinion that they are developed from those tubes of the organ of Rosenmüller which contain epithelium. They differ from ovarian cysts in being like the hyaline parovarian cyst, unilocular ; but they are sharply differentiated from the hyaline cysts by the fact that their walls present papillary growths or vegetations similar to those found in the proliferating papillary cysts of the ovary, and that their contents is more or less viscid, and often coloured from blood which has been extravasated from the papillary growths.

Solid tumours of the ovary.—Solid tumours of the ovary are not common, and call for no special description, as they differ in no marked manner from similar growths in other parts of the body. They may be fibromata or fibro-myomata, sarcomata and carcinomata.

The **fibromata** usually occur in young women ; their growth is very slow, and they give rise to no symptoms, unless they are accompanied by ascites. It is almost impossible to diagnose them from a sub-peritoneal uterine fibroid with a long pedicle.

Sarcomata may occur in quite early life, when they grow rapidly and speedily terminate fatally. They are also occasionally met with during the latter part of child-bearing life. The symptoms are those of a rapidly growing tumour with, in the later stages, ascites and cachexia.

Carcinomata.—True carcinoma of the ovary is very rare, but there is a certain class of tumour, which has been named *endothelioma*, which histologically is intermediate between the sarcomata and carcinomata, and which has an alveolar arrangement. These tumours would appear to originate in degenerated dermoid or papillary cysts. Clinically these tumours are very malignant, grow very rapidly, are attended by ascites, the ascitic fluid being often blood-stained, and are accompanied by rapid emaciation and failure of the strength. Carcinoma of the ovary may be secondary to cancer in other organs, as the uterus or the breast.

Etiology.—It is during the active, child-bearing life of females that ovarian diseases most frequently occur, but they have been met with at all periods of life, from the infant to advanced age—65 to 75. It must be borne in mind, however, that though ovarian *cysts*—for it is with this form of ovarian tumour that we are principally concerned—do not begin, as a rule, to grow and assert themselves till after puberty, the germ of many of them has existed from fœtal life, but has remained latent until the increased physiological activity of the ovary later on has called them into action.

Ovarian tumours appear to be more common in the married than in the single. Little is known as to the causes which produce ovarian tumours. It has been thought that heredity may have something to do with their formation, and cases of cysts in the same family, among sisters, have been observed.

Symptoms.—The early symptoms of an ovarian tumour, whether cystic or solid, are very indefinite. Often there are no symptoms at all until the tumour has attained a considerable size, and then it may be discovered by accident. In other cases certain symptoms may exist, which, however, are not attributed to the right cause. There may be scanty menstruation or amenorrhœa, or, on the other hand, there may be menorrhagia. There may be pain in the region of the sacrum, and this may be due to the ovary being prolapsed from its increased weight into the pouch of Douglas ; or there may be pain or numbness in the leg on the affected side from pressure on the sacral plexus, pain or difficulty in micturition, and constipation. As the tumour increases it not only fills the pelvis, but rises up into the abdomen, and there produces an enlargement, which is usually noticed to begin on one side. If the tumour is cystic, the swelling is rounded in general outline, though its surface may be irregular. It feels elastic, and a sense of fluctuation can generally be detected. In some cases where the tumour is unilocular, or where, in a multilocular tumour, one cyst attains a large size and forms the greater part of the swelling, the sense of fluctuation and a wave can be felt by placing the hand on one side of the tumour, and sharply tapping the other with the finger. When the swelling is made up of a number of smaller cysts the sense of fluctuation is not so well marked, and the wave across the tumour is absent. When these smaller cysts are filled with a colloid material, it may be impossible to distinguish the tumour from a solid growth. The swelling is more marked below the umbilicus, and is absolutely dull to percussion, the dullness being greatest at the summit, and gradually becoming less marked towards the periphery. The flanks are resonant. The dullness does not alter in character with alterations in the position of the patient.

When an ovarian tumour becomes so large as to distend the abdomen, it may press upon and irritate the stomach and intestines, and produce nausea and vomiting, diarrhœa and colic. The respiration becomes thoracic, and the heart may be displaced. The tumour may press upon the ureters, producing dilatation of the pelves of the kidneys, and subsequently nephritis. The urine passed is often small in quantity and concentrated, and may be albuminous. The patient's health suffers; there is impaired digestion and loss of appetite; she is worn by pain, want of sleep, and mental anxiety; she emaciates, and her face assumes an expression of anxiety and suffering.

Upon examination per vaginam, which should always be done by the bimanual method, the patient lying on her back, the relations of the tumour to the pelvic viscera can be ascertained. It is usually situated behind the uterus, which is generally displaced to one side. The tumour will be felt to be free of the uterus, and upon introducing the sound the uterine cavity will be ascertained to be of normal size.

Diagnosis.—The diagnosis of ovarian dropsy is not always easy, and it has frequently been mistaken for other conditions, of which perhaps the following are the most common: (1) ascites; (2) pregnancy; (3) fibroid tumours of the uterus; (4) cystic disease or large cysts of the kidney; and more rarely for hydatids, distended gall bladder, pancreatic cysts, hydro-salpinx, and cyst of the mesentery, phantom tumours, and many other conditions.

1. From *ascites* it can usually be recognised by a careful examination of the abdomen. It will be noted that in ascites the abdomen protrudes more at the sides than in front, where it is more flattened and less conical than in ovarian tumour. The greatest circumference of the belly is above the umbilicus, rather than below it, in ascites. It may be noticed also that the shape of the belly changes with alterations in the position of the patient, bulging at the most dependent part, and this is not so marked in ovarian dropsy. Upon percussion it will be found that in ascites the flanks are dull, and, indeed, if the peritoneal cavity is full of fluid, the abdomen will be uniformly dull; if not so full, there will be resonance above the umbilicus, from the tranverse colon and small intestines floating to the surface, when the patient is lying on her back. The dullness varies with position; when the patient is lying on her side, the flank which is uppermost will be resonant. In ovarian dropsy the

flanks are resonant and the dullness is in front, its limits being sharply marked. In ascites the wave of fluid may be felt not only where the sound is dull on percussion, but also beyond the line of dullness. This is not so in ovarian disease, where the sensation of fluctuation is distinctly limited to the cyst. The history of the case and the evidence of any disease of the liver, heart, or kidneys may also aid in the diagnosis, since these diseases are the cause of ascites; though, of course, it is quite possible that a patient suffering from disease of these viscera may be the subject of ovarian dropsy. In cases of doubt further information may be obtained by withdrawing a small quantity of the fluid by means of an exploring syringe. There is no difficulty in distinguishing the thick, glairy, gum-like fluid of an ordinary ovarian cyst from the thin, greenish serum of ascites. But the fluid of a unilocular cyst of the broad ligament somewhat resembles ascitic fluid. If this fluid, being allowed to stand, deposits a small coagulum spontaneously, the chances are in favour of its being ascitic. If on microscopic examination cylindrical epithelium is found, the probabilities are in favour of its being an ovarian cyst.

2. Ovarian dropsy has been mistaken for *pregnancy*, or, what is worse, pregnancy has been mistaken for ovarian disease. Of course, in many cases this cannot occur; when, for instance, the patient is beyond the child-bearing age, or the tumour has been known to exist for a longer period than nine months. Whenever the patient is of the child-bearing age, the possibility of pregnancy must not be forgotten, and it must be borne in mind at the same time that pregnancy may be present in a case of ovarian disease. The most important evidence can be obtained by vaginal examination, when it can be generally ascertained that the uterus and tumour are one. The condition of the os uteri and the presence of 'ballottement' will also assist in the diagnosis. After the sixth month the movements of the fœtus may be felt, and the sound of the fœtal heart may be heard. The condition of the breasts should also be ascertained.

3. Another source of error is mistaking a *softened fibroid tumour* of the uterus for an ovarian cyst. In these cases the uterine sound is of great assistance in arriving at a diagnosis, but it should never be introduced until all doubt as to the existence of pregnancy has been set at rest. With the sound in fibroid tumour it will probably be found that the uterine cavity is elongated, and that the tumour moves with alterations in the position of the sound. Under these circumstances, it is either uterine or else an ovarian cyst which has become closely connected with the uterus.

4. The diagnosis from *large cysts of the kidney* or *hydro-nephrosis* is sometimes difficult. These tumours generally present more in one flank than ovarian tumours, and this flank is very markedly dull on percussion. The dullness rarely, however, extends far beyond the middle line in front, towards the opposite side of the abdomen. In cases of disease of the kidney, the colon which lies in front is generally pushed forwards, and may be detected by a resonant note in front of the tumour.

It is impossible in the limits of this work to discuss the differential diagnosis of all the various conditions for which an ovarian tumour may be mistaken; a careful examination will generally prevent any error being made, though, in cases of doubt, an exploratory incision may be necessary before an accurate diagnosis can be arrived at.

Complications of ovarian tumours.—1. The wall of an ovarian cyst, or rather the peritoneum covering it, may become inflamed. This is accompanied by sudden and severe attacks of pain in the abdomen, with fever. It usually results in adhesions, which glue the cyst to the abdominal wall and to the other viscera of the abdomen. These adhesions are often very difficult to detect before operation; though they may be suspected by the history of attacks of pain, and by noting whether the tumour moves up and down during respiration. If adhesions are present and are firm, the tumour and the abdominal wall move together.

2. Suppuration may take place in an ovarian cyst. This may be due to the introduction of pyogenic organisms through a puncture in tapping or aspiration; but in most cases is probably caused by adhesions having taken place between the cyst and the intestine, and to the bacillus coli communis finding its way into the cyst at the adherent spot, where possibly the coats of the bowel may have been altered in structure and thinned. In these cases there is pain and tenderness, fever and probably rigors. The abscess may burst into the rectum, vagina, or bladder, or it may point on the abdominal wall, especially at the umbilicus.

3. Rupture of the cyst may take place either as the result of traumatism or spontaneously. This is usually followed by death from hæmorrhage or peritonitis, though a few cases have been recorded where recovery has taken place. These are cases where the rupture has probably taken place gradually, and the contents of the sac have leaked slowly into the peritoneal cavity and been absorbed.

4. A curious complication of ovarian cyst which sometimes occurs, where the pedicle is long, is an axial rotation of the cyst and a twisting of the pedicle. If the twist in the pedicle is very acute and tight, complete strangulation of its vessels takes place, and gangrene and sloughing of the tumour follow. If it is less acute, the veins become occluded, while the arteries still convey blood to the tumour; a condition of extreme venous engorgement results, possibly followed by rupture of the sac. When the rotation occurs slowly, the cyst may atrophy and become a solid mass. Sometimes in these latter cases, where adhesions have taken place between the sac and surrounding structures, the tumour is nourished from these sources and the pedicle disappears. The symptoms of this condition are a sudden accession of pain; alteration in the shape of the abdomen: in the area of dullness; in the relation of the tumour to the abdominal viscera; with collapse and subsequent symptoms of peritonitis.

Terminations of ovarian dropsy.—In the majority of cases ovarian disease if allowed to run its natural course proves fatal, either from pressure causing difficulty in taking food, and obstructing the circulation and respiration, or exhaustion from loss of albuminous material in the fluid of the cyst. In exceptional cases spontaneous cure may occur, as in the cases alluded to above of rupture of the cyst; twisting of the pedicle; or in cases of suppuration, in which the cyst bursts either externally or into one of the natural passages of the body. But these cases are very rare. A dermoid cyst may remain quiescent for years and cause little or no trouble.

Treatment.—The only treatment for ovarian tumour is removal, when removal is practicable. The operation should be performed as soon as the disease is recognised; and when it is cystic, as it usually is, the surgeon should not wait until the tumour becomes a source of trouble to the patient or a danger to her life. Early operation should be advised for several reasons: in the first place, because it is much less dangerous, a smaller incision is required, and probably no adhesions are present, or if there are any they are more easily dealt with; secondly, because the patient is saved from the risks which always attend ovarian cysts, inflammation, rupture or twisting of the pedicle; and thirdly, because the patient is in a better condition to submit to the operation than if she waits until, by its size and pressure, the tumour produces those secondary effects which have been alluded to above.

It does not seem worth while to allude to the medical treatment, since no drug or course of medicinal treatment can have any effect on ovarian tumours; or to those plans of treatment which were resorted to by the older surgeons, before MacDowell of Kentucky first performed ovariotomy in 1809, or when ovariotomy was in its infancy; such plans of treatment as tapping, tapping and pressure, tapping and the injection of iodine, tapping through the vagina or rectum, or tapping with drainage. All these operations, with perhaps the exception of simple tapping in certain cases, are now discarded. No doubt the so-called success which formerly was said to follow, was due to the fact that in some cases the disease was spontaneously undergoing periods of arrest which were mistaken for cure.

With regard to simple tapping or aspiration, there are some cases where it may have to be resorted to: as (1) for diagnostic purposes; (2) when the patient or her friends will not consent to the major operation; and (3) where there is organic disease elsewhere, which forbids any great surgical proceeding. In the two latter cases it is done simply as a palliative measure. Some surgeons still advocate tapping in the hyaline parovarian cysts, and it is an undoubted fact that some of these cysts can be cured by this method. But it would appear that the operation is almost, if not quite, as dangerous as extirpation; it may not result in cure, but, on the other hand, may lead to adhesions which will complicate any future operation. And furthermore it is impossible to diagnose the hyaline from the papillary parovarian cyst, and tapping in this latter condition is always extremely dangerous, from the risk there is of causing invasion of the peritoneum by the papillary growths. It would seem preferable, therefore, in these cases to resort to the operation of ovariotomy in order to effect a certain cure.

Ovariotomy.—It is advisable for some few days before the operation to confine the patient to bed, on an easily digestible and nutritious diet. The bowels should during this time be acted upon by a mild aperient daily, and a warm bath may be given every night. The day before the operation the pubic hair should be removed, and the abdominal wall properly cleansed and sterilised. On the morning of the operation the rectum should be emptied by an enema, and a catheter should be passed just before the patient is placed on the operating table, to insure that the bladder is empty. The patient should be warmly clad, the lower extremities being wrapped in small blankets and the upper part of the body well covered. The patient should be placed on a hot-water pillow, and the temperature of the operating room should not be below 65° F.

The best anæsthetic in the majority of cases is ether, but the anæsthetist should be prepared to give a little chloroform if the muscles are rigid and will not relax. When anæsthesia is complete, and the abdomen again cleansed and surrounded by macintoshes covered by towels wrung out in some antiseptic solution, an incision is made in the linea alba below the umbilicus, about four or five inches in length, and the peritoneum exposed. Before it is opened, all bleeding from vessels in the abdominal wall is to be arrested. When this is done, the peritoneum is opened by seizing it at the upper part of the wound and making a small opening in it. There is sometimes difficulty in doing this ; the serous membrane may be so closely adherent to the anterior wall of the cyst that the one cannot be separated from the other. Under these circumstances the incision must be prolonged upwards until a point is reached where the one membrane can be raised from the other. As soon as a small opening has been made in the peritoneum, it is to be slit up to the full extent of the external wound. This is best done by a pair of elbow scissors guarded between two fingers. The cyst is now exposed. Formerly it used to be the practice to introduce the hand into the abdomen, and, sweeping it over the surface of the tumour, break down any adhesions which might exist on its anterior surface ; but Mr. Knowsley Thornton advises that this should not be done, as hæmorrhage may occur from the tearing of small vessels, which being on the stretch cannot contract. When, therefore, the cyst is freely exposed, a Spencer-Wells trocar should be inserted into it and the fluid drawn off. As soon as a little has escaped, it will be possible to seize the cyst around the puncture with the claws with which the trocar is provided, so as to prevent the escape of any of the fluid by the side of the instrument. Every care must be taken by packing sponges around to prevent any of the fluid getting into the peritoneal cavity. If the tumour consists mainly of one large cyst, and there are no adhesions, it will be found that as the fluid flows away the tumour may be delivered by gentle traction ; but if there are adhesions, this will not be so. If the fluid does not flow after a few ounces have escaped, it will be clear that the cyst is multilocular, and only one small compartment has been opened. Two courses are open to the surgeon : either he may thrust the trocar about as it remains in the first cyst, in the hope of puncturing others ; or he may withdraw it, close the opening with a pair of clip forceps, and puncture in another place ; probably this latter procedure is the safer. If no fluid escapes, it will be evident that the contents of the cyst are too solid to be discharged through the trocar, which must therefore be withdrawn and the puncture enlarged sufficiently to admit the fingers of the surgeon, with which the solid contents must be scooped out. While this is being done, the edges of the incision in the cyst are kept well outside the abdomen by assistants holding them in clamp forceps. Under these circumstances the external wound will require very considerable enlargement before the tumour, even though it has been considerably reduced in bulk by these means, can be delivered.

After the cyst has been reduced in size, adhesions, if any exist, will have to be dealt with. Sometimes they are so soft that they can at once be broken down by pressure without exerting any force ; at other times they are too tough to yield to simple measures ; they must then be separated bit by bit with the finger nail or a director, any bleeding points being at once secured. In some cases, especially when the adhesions have taken place between the intestines and the cyst, they cannot be broken down without using an unjustifiable amount of force. In these cases a thin layer of the cyst wall should be left adherent to the intestine, and the rest of the cyst removed. Subsequently this small piece of cyst can be got rid of by careful dissection. Occasionally it may happen that the adhesions are so firm and so extensive, especially when situated in the pelvis, that the whole of the sac cannot be extirpated. The only resource then is to remove the upper part of the sac and fix the edges of the remainder to the margins of the abdominal wound. In doing this the peritoneal cavity must be entirely shut off, by stitching up all the upper portion of the wound and leaving open only a sufficient extent at its lower end to allow of the suturing of the remains of the cyst.

In those cases where the adhesions are not so firm, the cyst may be drawn gradually and gently from the wound by a side-to-side movement. While this is being done, the assistants exert pressure on the edges of the abdominal wound to prevent the escape of the intestines from the peritoneal cavity. When the whole of the tumour has been delivered, the pedicle is to be tied, divided, and returned into the abdomen. The pedicle is unfolded and its centre found. Through this an aneurism needle armed with a loop of strong silk or whip-cord, carefully sterilised, is passed. The loop is seized and divided, and the needle withdrawn. The two pieces of cord are now interlocked and tied as tightly as possible around the two halves of the pedicle, and finally one of the strings is made to encircle the whole pedicle and tied, and both are cut off short. The pedicle is divided about half an inch beyond the ligature, and if on examination it is found to be perfectly dry, it is allowed to drop back into the pelvic cavity. The other ovary is then sought for and brought up to the surface for inspection. If this is found to be diseased, it must be removed. The next step is to clean up the peritoneal cavity. When the operation has been simple, and no fluid from the cyst has escaped into the abdominal cavity, it is unnecessary to waste time in an elaborate 'toilet' in sponging out any small quantity of blood; but when the cystic fluid, and especially if it is purulent, has escaped into the peritoneal sac, it should be scrupulously removed. This is done by warm aseptic sponges, and must be persevered with until they return dry and colourless. The surgeon has now only to close the abdomen. When the operation has not been protracted, and the patient's condition is good, the better plan is to suture the abdominal wall in three layers: first the peritoneum is united by a continuous catgut suture; then the aponeuroses of the abdominal muscles in the same way; and finally the integument with fishing-gut or silk sutures. When, however, time is of importance, and it is desirable on account of the patient's condition to complete the operation as soon as possible, the various layers of the abdominal wall may be sutured together, care being taken to include the peritoneum in each stitch. The question of drainage must depend mainly upon whether any septic fluid has entered the peritoneal cavity, or there is any fear of subsequent oozing of blood. The usual antiseptic dressings are applied. The patient is placed in bed, previously warmed, with her thighs slightly flexed over a pillow and enveloped in blankets. Nothing should be given by the mouth during the first twenty-four hours, except a little hot water occasionally to allay the sickness produced by the anæsthetic; if nourishment and stimulation are judged to be necessary, they should be administered by the rectum. The urine should be drawn off periodically. On the second day a little food may be given by the mouth; and after the fourth day, if everything is going on satisfactorily, light solid food may be given. The wound may be dressed and the stitches removed on the tenth day.

Among the causes of death are shock, peritonitis, hæmorrhage from the slipping of a badly applied ligature, intestinal obstruction, and more rarely phlebitis, embolism, and tetanus. Inflammation of the parotid glands (see page 731) and acute mania have sometimes followed the operation.

Parametritis (pelvic cellulitis).—Inflammation occasionally attacks the connective tissue between the layers of the broad ligament, and this is termed *parametritis.* It arises from many causes: operations about the cervix ; as a complication of delivery or abortion ; or from inflammation spreading from the Fallopian tubes. The inflammation may or may not run on to suppuration. If abscess forms, it may point in the vagina, the rectum, or the bladder, or tracking along the course of the round ligament it may point in the groin.

The **symptoms** are pain and tenderness in the region of the affected tissues, with considerable fever and possibly a rigor. As exudation supervenes, a tense resisting swelling can be felt just above the brim of the pelvis in front, and there is pain and difficulty in micturition and defæcation. Upon examination by the vagina a hard mass will be felt in one or both broad ligaments. The advent of suppuration is indicated by increased temperature and rigors. The hard mass in the broad ligament will become softer, and after a time fluctuation may be detected.

Treatment.—The treatment must consist, in the early stage, in absolute rest in bed, a fluid diet, saline aperients to keep the bowels freely acting, and hot fomentations to the abdomen ; hot vaginal douches are also often comforting to the patient. When matter forms, the pus must be evacuated. Sometimes, when it is distinctly pointing into the vagina, an opening may be made through this canal and a drainage tube inserted, through which daily irrigation can be carried out. When the abscess shows a tendency to point in the groin, it may be opened in this situation by an incision just above Poupart's ligament without involving the peritoneal cavity.

DISEASES OF THE BREAST

Abnormalities of the breast.—The abnormalities to which the breast is liable may be (1) congenital, or (2) acquired.

1. The *congenital* abnormalities consist either in the existence of supernumerary breasts or in the absence or imperfect formation of these organs.

Supernumerary breasts (*polymazia*) are not uncommon, and under this head may be included three different conditions : (1) supernumerary breasts with nipples ; (2) supernumerary breasts without nipples ; and (3) supernumerary nipples without breast structure. The last of these three conditions is the most common ; the first is the most uncommon. Nevertheless undoubted cases have been recorded of an additional breast, which has been complete in structure and has secreted milk. The most common situation for them to be found is on the anterior surface of the trunk, below the level of the normal mammæ. They are also found in the axillæ, in the groin, lumbar region, outer side of the thigh, and in other regions. Not infrequently a mass of mammary tissue is found just under cover of the anterior fold of the axilla, which is devoid of nipple or excretory ducts. It is not improbable that this is merely a prolongation of the breast itself. The supernumerary breast is usually rudimentary, and rarely gives rise to any inconvenience. If it does it should be removed.

Complete absence of the breast (*amazia*) is very rare. More frequently a rudimentary condition has been noted, in which the breasts are small and undergo no enlargement at puberty. This condition is said to exist most frequently in cases of congenital absence of the ovaries.

2. The *acquired* abnormalities of the breast consist in hypertrophy or atrophy.

Hypertrophy of the breast is not common, if we exclude those cases where there is an exaggerated enlargement at puberty or during pregnancy, without the breasts attaining such an enormous size as to become a deformity. In those cases where the breast attains such an enormous size as to become unwieldy, and to which the term hypertrophy is limited, there does not appear to be much increase in the gland tissue; it is the connective tissue and fat which are principally hypertrophied. Many of the cases which have been described as hypertrophy have been probably cases of diffuse adeno-fibroma. The condition is characterised by a steady progressive increase in the size of the breast or breasts, which, as a rule, causes no pain—merely discomfort from its weight. It usually begins in the young woman, often soon after puberty. But it may occur later in life, both in the married and the single. It can be distinguished from tumour of the breast by its uniform even feel, and by the fact that both breasts are usually affected. The treatment consists in improving the general health and in keeping up uniform pressure by strapping or bandage. When the hypertrophy is so great as to cause inconvenience and deformity, and if treatment fails to effect a cure, the removal of the breast is the only alternative.

Atrophy occurs naturally at the menopause, but may also occur occasionally in young women, and may result from an attack of mastitis or from too prolonged lactation.

DISEASES OF THE NIPPLE

In some women the nipple is naturally retracted or depressed, so that the child is unable to grasp it in sucking. This may be the source of considerable discomfort, or even worse, as the child in its efforts to seize the nipple is very likely to excoriate it, and this may lead to abscess of the breast. If this condition is noted during pregnancy, attempts should be made to draw the nipple out by means of an exhausting pump. And if after delivery the child is unable to grasp the nipple, the milk must be drawn off by means of a breast pump, and the child fed with it.

Cracked or fissured nipple (*sore nipple*). This is a very common complaint, especially amongst women who are nursing their first child. It is often due to want of attention in properly drying the parts after suckling, and may also be due, as above stated, to a badly developed nipple. The nipple becomes swollen, red, and superficially excoriated, and great pain is experienced in 'giving the child the breast.' In some cases there is considerable constitutional disturbance. Where cracked nipples exist, it is desirable to use some form of artificial shield for the nipple, or to draw off the milk with the breast pump, for the condition is very likely to result in acute abscess of the breast or of the axillary glands.

Treatment.—The treatment of 'cracked' nipples is in a great measure preventive. Every mother ought to be instructed after suckling to wash the nipples with warm water, to which a little borax or other mild antiseptic has been added, and then to dry them thoroughly with a soft napkin or cambric handkerchief. When fissures or cracks are once formed, the child should be withdrawn, and the nipple dressed with glycerine jelly and borax, or with a lotion containing some astringent, as zinc or lead. The old-fashioned plan of touching the fissures with a point of nitrate of silver often succeeds in curing them when other means fail.

Eczema of the nipple.—Under the term eczema of the nipple are included two different diseases: ordinary eczema, which is identical with eczema in other parts; and Paget's disease, which was described by

Paget as a form of eczema, but which is now believed to be due to the presence of psorosperms.

Ordinary **eczema** of the nipple usually arises from the same cause as cracked nipples, and is closely associated with it. From want of cleanliness, and attention to the part after suckling, the nipple becomes swollen and raw looking ; it discharges, and the discharge dries and forms yellow crusts, and burning pain and itching is complained of. The condition may spread to the surrounding skin, and it then presents all the characters of eczema. The treatment is the same as that of eczema in other parts, but it is essential that the child should be weaned.

Paget's disease.—This disease of the nipple is not a true eczema, but a destructive dermatitis of the papillary layer of the skin ; scrapings from and sections of the skin show under the microscope large vacuolated cells, which are believed by some to be psorosperms, but the question cannot be regarded as definitely settled. The disease terminates in a peculiar form of carcinoma of the surrounding skin, and frequently, but not invariably, carcinoma of the breast follows. It presents an excoriated, bright red surface, which discharges a viscid, yellowish fluid, and spreads until the whole of the areola is involved. Burning pain is complained of in the part. Later on ulceration may occur, and the whole of the nipple may be destroyed. If the mamma becomes secondarily affected, the form of cancer is usually of the squamous carcinoma type, the disease originating from the epithelium of the larger ducts. It is important to diagnose between ordinary eczema of the nipple and Paget's disease, as this latter is not amenable to treatment by local measures such as are successful in the former ; and it may be mentioned as an aid to diagnosis that the patches in Paget's disease are sharply defined at their margins, and do not present a gradual shading off as is the case in eczema. The result of treatment is, however, the best indication of the nature of the disease. As regards treatment, no local measures are of any avail, and when the diagnosis is established with certainty, and all palliative measures have failed, the wiser course would appear to be to remove the breast, especially if the tissues at the base of the nipple are beginning to be infiltrated.

Abscess of the nipple sometimes occurs in nursing women, in association with a cracked nipple, or in unmarried women from a suppurating sebaceous follicle. It is usually circumscribed, and shows little tendency to spread. In the early stages it must be treated with glycerine and belladonna, with warm fomentations, and, when matter has formed, by a small incision, which should be made in the long axis of the nipple.

Chancre of the nipple is usually seen in a wet nurse—that is, a non-syphilitic woman—from nursing a syphilitic infant. Colles's law that a mother cannot be infected by her syphilitic offspring, even though she has apparently no syphilitic taint, prevents a mother being affected with chancre from her child when nursing it. A chancre on the nipple does not always present the characteristics of a Hunterian sore. It generally appears as a small circular ulcer, without much induration around, and without any great amount of tenderness. Any sore on the nipple of a woman who is nursing a child other than her own should excite suspicion, and the child and its parents should be carefully examined for any syphilitic lesions.

Tumours of the nipple.—The nipple is occasionally the seat of pendulous papillomatous growths, or of sebaceous cysts ; more frequently of epithelioma or rodent ulcer. They require no special description.

INFLAMMATORY AFFECTIONS OF THE BREAST

Mastitis neonatorum.—In infants, about the third or fourth day after birth, the breasts not infrequently become swollen and red, and the child cries when they are handled. Upon squeezing the breasts a small quantity of milky fluid may be expressed from the nipples. The disease is said to be caused, or, at all events, aggravated, by a habit which nurses have of rubbing and pulling the nipples. Formerly these cases often ran on to the formation of abscess, but now that they are simply treated by rest and cleanliness, and the pernicious practice of squeezing and pulling the nipple is to a great extent abandoned, abscess is very rare.

Inflammation of the breast at puberty is not uncommon, both in boys and girls. The breast becomes swollen, painful, and tender, and sometimes there may be a little serous exudation from the nipple. It usually subsides of itself, and rarely goes on to the formation of matter. The breast should be shielded and protected by a belladonna plaister.

Acute mastitis.—Acute inflammation of the breast in adults is, in the great majority of cases, associated with lactation ; though it may occur in non-puerperal women as the result of injury, or after mumps or typhoid fever, or a pyæmic abscess may form in the breast. When occurring in connection with lactation it most usually shows itself about the end of the first month, but may occur earlier, within the first fortnight, and at any time up to the termination of lactation. In the majority of cases acute mastitis, occurring in puerperal women, runs on to suppuration and the formation of abscess, and there seems no reason to doubt that it is invariably produced by the invasion of pyogenic organisms which have found an entrance through some crack or abrasion of the nipple. Hence, 'sore nipples' are a fertile source of this disease. When these organisms effect an entrance through some abrasion of the nipple, they find their way through the lymphatics into the substance of the breast, and set up an inflammation of the interstitial tissue between the lobules, which rapidly runs on to suppuration. Some pathologists believe that the organisms may effect an entrance through the ducts of the gland, and in this way cause suppuration in the alveoli of the gland substance itself, constituting what has been called *galactophoritis*. It is doubtful, however, whether this is so, and at all events the point cannot be regarded as definitely settled. Formerly it was supposed that puerperal mastitis was due to the retention of the secretion in the acini and ducts of the glands, and was due to over-distension, but this is not now believed to be so, as engorgement takes place when suckling is suddenly interrupted, and is rarely followed by abscess.

Formerly it was customary to describe abscess of the breast as occurring in three situations, as the supra-mammary, intra-mammary, and sub-mammary abscesses, and it is no doubt true that abscess may occur in these three situations ; but the only ones of any real practical importance in connection with diseases of the breast are the intra-mammary abscesses, which occur in the interstitial tissue between the lobules or, it may be, in the lobules themselves. The supra-mammary abscesses are merely instances of suppuration in the subcutaneous tissue ; they may originate in a superficial lobule, but far more frequently arise from causes quite unconnected with the gland. They are to be treated in the same way as a similar condition in other situations. The sub-mammary abscess is situated in the connective tissue beneath the breast. It is very rare, and though possibly it may arise in connection with one of the deep lobules of the breast, it is far more frequently due to other causes, such as necrosis of the ribs or costal cartilages, tuberculous disease, or some such cause. In these cases the swelling is beneath the breast, which is pushed forwards and rests on the swollen tissues. If the matter points, it is usually at the periphery of the organ, generally at its most dependent part.

Symptoms of intra-mammary abscess.—The patient complains of a sense of weight and aching pain in the breast, especially whilst the child is being suckled, and this is accompanied by a certain feeling of malaise and discomfort, alternations of heat and cold, or it may be the disease is ushered in with a rigor. This is speedily followed by the typical signs of acute inflammation. The breast, generally at its lower part, is swollen and indurated, acutely painful, tender on pressure, hot to the touch, and the skin over it may be more or less reddened. Conjoined with these signs is a rise in the temperature, the pulse is quick, and the tongue furred. After a time the skin over the swelling becomes œdematous and fluctuation is detected.

Treatment.—The treatment consists first of all in weaning the child. Some surgeons recommend that the child should not be weaned, but excluded from the affected breast ; but it is better to wean it at once; in the first place, because abscess of the breast almost always occurs in women who are weak and anæmic, and in whom therefore the exhaustion produced by lactation, in conjunction with suppuration, is more than they are able to bear ; and secondly, because if the child is still suckled with the sound breast a certain amount of engorgement is kept up in the affected one. If necessary the milk must be drawn off with a breast pump, and bromide of potassium may be given until the secretion has ceased. The affected breast must be smeared all over with a mixture of equal parts of extract of belladonna and glycerine, which will further arrest the secretion, and covered with a hot fomentation. It must be well supported. The best way of doing this is by passing a soft silk handkerchief, folded as a cravat, under the breast, with one end over the shoulder on the sound side ; the other under the axilla on the affected side, and tying the two ends together behind the patient's back. The arm should be supported by a sling. The bowels are kept acting ; a light nutritious diet should be ordered, and tonics—quinine, or bark and ammonia, should be given. If suppuration occurs, the abscess should be opened as soon as fluctuation is evident. This must be done, with strict antiseptic precautions, by an incision, in a line radiating from the nipple. These incisions should be made freely, so as thoroughly to open up the interstitial tissue between the lobules, and more than one may be necessary in the same case. After the suppurating tissues have been well irrigated with hot corrosive sublimate solution, a drainage tube or tubes should be inserted, and an antiseptic dressing applied. The breast will require dressing daily, and on each occasion the drainage tube may be shortened, until it is entirely removed. By these measures chronic suppuration and the riddling of the gland with sinuses, which so often followed abscess of the breast in former days, will be averted. In cases where an intra-mammary abscess has been allowed to burst, septic sinuses very often persist and require enlargement, scraping, and efficient drainage. During the process of suppuration the patient's strength must be supported by strict attention to hygienic and dietetic measures ; by the administration of tonics and stimulants, as the case may seem to require.

Chronic mastitis (*chronic lobular interstitial mastitis*).—This condition usually occurs in women about the time of the menopause, but may occur also in much younger women. The causes of the condition are very obscure. It is often associated with some uterine or ovarian irritation, especially in single women, or in married women who have never borne children. It has been attributed to injuries and to the pressure of ill-fitting corsets. Syphilis also is believed to play a part in the causation of this malady.

Pathology.—The disease consists in a chronic inflammation of the connective tissue of the affected lobule, which becomes the seat of an inflammatory exudation, crowded with round cells. These cells undergo development into fibroid or scar tissue, which, like scar tissue elsewhere, contracts, and by its contraction presses upon and partially obliterates the acini and ducts of the gland tissue. In consequence of the constriction of the ducts, the secretion in the acini is retained and they become dilated, and thus a number of retention cysts are formed, which as a rule do not attain a large size. The disease is usually limited to a single lobule, but occasionally may be more widely spread, and the whole gland becomes involved. Under these circumstances the breast becomes shrivelled, hard, and nodulated, and as the newly formed tissue contracts it drags upon and causes retraction of the nipple, and thus the condition to a great extent simulates scirrhus, more especially as the axillary glands are sometimes enlarged.

It is generally believed and taught that chronic mastitis is often the precursor of cancer, and that a lobule of the breast affected with this condition is very likely to be the seat of a carcinoma; but there are others who believe that in those cases where a supposed chronic mastitis has terminated in carcinoma the disease was cancerous from the beginning, and that no previous inflammation existed. It must be stated that it is extremely difficult to distinguish microscopically between early carcinoma and chronic mastitis, since in this latter condition the epithelium of the acini and tubes is often in a state of marked proliferation.

Symptoms.—The patient's attention is usually attracted to the disease by pain, and she will then discover a lump, which is nodulated and indurated, and tender to the touch. The induration lacks the stony hardness of cancer, and though a distinct tumour can be felt, it will generally be found that the rest of the gland tissue is not healthy, but that the whole organ feels more or less lumpy, knotty, and hard. Upon picking up the gland between the finger and thumb, the tumour is apparently definite and circumscribed, but on pressing the gland against the wall of the chest with the palm of the hand no tumour can be felt; this forms an important means of diagnosis between chronic inflammation and tumours of the breast, whether they be scirrhus, adeno-fibroma, cysts, or chronic abscess. The pain is sometimes very severe and is of a neuralgic character, radiating down the arms, and over the chest to the neck and axilla. The nipple is often retracted, but the skin is rarely puckered, or adherent to the swelling. There may be a little serous discharge from the nipple. The disease usually occurs in women who are pale and anæmic. Only one, or both breasts may be affected. The resemblance of this disease to cancer of the breast is very considerable, and it may not always be possible to diagnose between the two conditions.

Diagnosis.—The chief points to be attended to in coming to a correct conclusion are that the swelling of chronic mastitis is less circumscribed, and less easily outlined than in cancer, and that the rest of the breast is knotty and hard, and that probably the other breast will be in the same condition. A further point is that on pressing the breast against the wall of the chest, the sensation of a definite tumour is not felt. And thirdly, in inflammation there is no dimpling of the skin or adhesion of it to the surface of the swelling in the majority of cases. This condition has, however, been observed in isolated instances.

The disease may remain stationary for years, without causing the patient any serious disability, or it may disappear, or become markedly better, under treatment. In many cases, however, it progresses and terminates either in a general cystic formation, or in complete atrophy of the glandular tissue. On the other hand, it is probable that it may become carcinomatous (vide supra).

Treatment.—The treatment of chronic mastitis consists in the local application of mercury and pressure, and the internal administration of the iodides with tonics A piece of lint sufficiently large to cover the whole breast, with a hole cut in it for the nipple, is spread with oleate of mercury or blue ointment, and placed over the breast, which is then carefully strapped by long strips of strapping, which are applied from just above the spine of the scapula on the side opposite to the affected breast, over the clavicle, under the diseased breast, across the axilla, and round to the back again. These straps are applied so as to partly overlap each other until the necessary support is given to the breast. Cross strips are then applied across the front of the chest to compress the upper part of the breast. Internally iodide of potassium should be given, and this should be combined with iron (the ammonio-citrate or potassio-tartrate), as these patients are almost always anæmic.

If improvement follows these means they should be persevered with; but if no improvement is noted, and the tumour is a source of annoyance and anxiety to the patient, from a dread of cancer, as is so often the case, the lobule should be removed, or if the whole breast is affected, amputation should be performed, especially if the patient is approaching, or has passed, the menopause.

Chronic abscess of the breast.—This is a condition of considerable importance, since it is likely to be, and occasionally has been, mistaken for scirrhus. It consists of a small collection of pus situated in a lobule of the breast and surrounded by a layer of dense indurated tissue, in which remains of gland tissue can be detected. These abscesses usually arise in connection with pregnancy; very often after abortion or miscarriage. They are also said to occur sometimes after mastitis in young girls. There seems very good reason to believe that they may be also sometimes tuberculous. They form a hard, solid lump in the breast, implicating the gland structure, from which they cannot be separated. They are not very defined. There is often some dimpling of the skin and retraction of the nipple. They may be the seat of some pain and are often tender to the touch. In these respects they resemble a scirrhous tumour. They may generally be distinguished from it by noting that the hardness is not so stony; that the centre is not so hard as the circumference, and that a sensation of elasticity, or even deep fluctuation, may be felt. Moreover, the skin over them is sometimes œdematous, and at all events does not present the pigskin appearance of scirrhus. If any doubt exists it can be at once solved by the introduction of an exploring syringe.

Treatment.—The treatment consists in laying open the cavity, scraping away the granulation tissue by which it is lined, disinfecting it, and dressing it up from the bottom with antiseptic gauze.

Tuberculosis of the breast is now believed to be much more common than was formerly supposed; many cases, which were regarded as chronic mastitis, going on to suppuration, are now known to be tuberculous. The disease runs just the same course as tuberculous disease elsewhere. The tubercle bacillus effects a lodgment usually in the inter-acinous tissue and forms a nodule, which slowly undergoes caseation, breaks down into a curdy fluid, and comes to the surface. There may be only one deposit, but there are usually more, each forming a separate abscess; but as a rule they are limited to one section of the breast, and do not involve the whole organ. For the most part they occur in young women, and in those who present evidences of tuberculous disease elsewhere. The disease is characterised by the formation of one or more irregular lumps in the breast, without much pain, which gradually soften, and eventually fluctuate. After they burst they form sinuses which present the characteristic undermining of the skin and have no tendency to heal.

Treatment.—The treatment of tuberculous disease of the breast must depend in a great measure on the condition of the patient and the condition of the breast. If there is advanced tuberculous disease elsewhere, e.g. in the lungs, no operative interference is admissible. If the patient is a young woman, during the child-bearing period of life, a very serious consideration comes into play. It is quite conceivable that, though by treatment the affection of the breast may be apparently cured, and the sinuses healed, there may still be some latent mischief at the seat of the old lesion, which might prove a source of danger to her child, should she later on have one and suckle it. It becomes a question, therefore, whether it might not be right under these circumstances to advise removal of the organ. If the disease has extensively infiltrated the breast there can be no question that this is the right course to pursue, especially as it is very doubtful whether anything short of removal of the breast will cure the disease. But if there is only a single caseating focus, probably the patient will scarcely consent to have the whole breast removed, and therefore in these cases the sinus should be enlarged, scraped, and disinfected, and the general condition attended to. In elderly women, who are past the child-bearing period of life, excision of the affected segment of the breast may be sufficient to effect a cure.

Syphilis of the breast.—It has already been pointed out that the breast may be affected with primary syphilis, in the shape of chancres occurring on or about the nipple, and that some cases of chronic mastitis may owe their origin to secondary syphilitic trouble. In addition to this mucous tubercles and condylomata are not uncommon in the breast, occurring principally on the nipple or areola. And as a tertiary manifestation gummata are in rare instances met with. These latter are usually well marked and require no special consideration.

TUMOURS OF THE BREAST

Tumours of the breast, like tumours elsewhere, may be divided into cystic and solid. In speaking of cystic tumours, one must be careful to differentiate between independent cystic tumours and cysts growing in solid tumours, which are so common in the breast. The former only of these two classes will be considered under the head of cystic tumours: the latter, cysts in tumours, will be described with the several solid growths in which they are formed.

1. **Cystic tumours.**—The independent cystic tumours are (*a*) retention cysts, (*b*) simple serous cysts, (*c*) parasitic cysts.

a. **Retention cysts** are of several different varieties. Some may occur in connection with lactation, and the fluid which is retained is milk, or some substance derived from milk. In the great majority of cases the retention takes place in one of the larger ducts, which becomes obstructed, but in some few cases it would appear to arise from some injury which causes rupture of a duct, or ducts, and effusion of milk, which becomes caseated in the connective tissue. The ordinary *galactocele* is, however, a dilated duct, generally situated near the nipple, the orifice of which has become obstructed owing to some inflammatory changes from cracked nipple, or from some injury, as incision of an abscess near the nipple; or it may be from malformation, or the lodgment of a concretion in the duct.

Symptoms.—They form oblong tumours, radiating from the nipple, which are painless and fluctuate. The veins over them are often a little enlarged. The swelling becomes firmer and tenser during the act of suckling. Their contents vary, sometimes containing an opalescent serous fluid, at others pure milk, but most frequently a semi-solid, cheesy material. These cysts sometimes disappear at the cessation of lactation, and recur at each succeeding pregnancy.

Treatment.—The treatment consists in either laying open the cavity, turning out the contents, and dressing it from the bottom, or in dissecting out the cyst. The latter plan of treatment will probably prove the better, and ought certainly to be followed if the walls of the cyst are much thickened. It is desirable to wait until lactation is over before proceeding to operate.

Retention cysts may also be formed in the breast, as a result of chronic interstitial mastitis, arising from the contracting fibrous tissue pressing upon and obstructing the ducts of the glands. These cysts have already been alluded to (page 1081). They vary in size, but usually most of them remain quite small, while one or two continue to grow, and attain considerable dimensions. The patient usually consults the surgeon for a distinct tumour, which does not cause much pain or inconvenience, and which may have been discovered accidentally. The tumour is well defined, movable, elastic, and fluctuation may be detected. On examining the rest of the breast other smaller tumours may be detected, or, at all events, the part of the breast in which the lump is situated will present the hard, knobby characteristics of chronic mastitis.

Treatment.—The treatment in these cases consists in either tapping the cyst, and possibly injecting iodine, or by removing it, together with the lobule of the gland to which it is connected.

Another form of retention cyst is the involution cyst, which occurs in the breasts of women after the cessation of active child-bearing life. They are closely allied to the preceding, and would appear to originate much in the same way, by the constriction of the gland tissue by the overgrowth of fibrous tissue around it. They are of no great practical importance, rarely attain any great size, and give rise to little or no inconvenience.

b. **Simple serous cysts** are small cysts which arise, not in the glandular structure as the result of retention, but in the connective tissue between the acini. They may be uni- or multi-locular spaces, and are composed of a delicate sac-wall, lined with endothelial cells, which are similar to those found in lymphatic vessels. They are supposed to be formed by the dilatation of lymph spaces, the surrounding connective tissues being pressed together and thickened. They usually contain a clear, straw-coloured fluid, but sometimes a brownish, turbid mucoid material. They grow slowly, and give rise to no pain or inconvenience. When situated superficially they may form a fluctuating swelling under the skin, but usually they are situated more deeply in the substance of the breast, when their diagnosis may be rendered more obscure, and be only possible by an exploratory puncture. They never contain any intracystic growths, and cause no discharge from the nipple.

Treatment.—If the wall of the cyst is thin, they may sometimes be cured by a simple tapping; that is to say, the fluid does not re-accumulate; but, as a rule, they require an incision, washing out the cavity with a solution of chloride of zinc, and packing with gauze. If the sac wall is very thick, the cyst must be dissected out.

c. **Parasitic cysts.**—*Hydatid cysts* have been described as occurring in the breast, but they are very rare.

The **symptoms** are those of other cysts in the breast, and probably the diagnosis cannot be made until the fluid is evacuated. They are slow in growth, and not usually attended by pain or inconvenience. The treatment consists in incision and removal of the cyst or evacuation of its contents, followed by antiseptic draining.

Dermoid cysts have been said to occur in the breast, but it is very doubtful whether most of the cases have not been galactoceles caused by the rupture of a duct (page 1084) or atheromatous tumours.

Solid tumours of the breast.—The usual varieties of solid tumour found in the breast may be classed under the heads of (1) adenoma, (2) sarcoma, and (3) carcinoma. The rarer forms of growth occurring in this organ, lipoma, chondroma, osteoma, and angioma, require no separate consideration, as they differ very little from similar growths in other parts.

1. **Adenoma.**—The adenomatous tumours are characterised histologically by a resemblance to ordinary glandular breast tissue, and clinically by their innocent nature and their tendency to occur during the period of life when the breast is capable of performing its natural function. They are all characterised by containing spaces or cavities lined by cubical epithelium; but the cavities are less regular in shape, and their epithelium is less uniform in arrangement than in normal breast structure. They may be small and microscopic, or they may be large and may contain, or be filled with, intra-cystic growths. They are surrounded and held together by connective tissue, which may vary in amount, sometimes being so great as almost to obscure and obliterate the spaces, which then exist as slit-like cavities, the walls of which are in apposition.

To tumours fulfilling these characteristics the prefix *adeno* is applied, and under this head we shall have to consider four different varieties of tumour, viz. (*a*) the pure adenoma; (*b*) the adeno-fibroma; (*c*) the adeno-sarcoma; and (*d*) the adeno-cystoma or cysto-adenoma.

a. **Pure adenoma.**—The pure adenoma, composed of well-formed glandular acini, without excess of connective tissue around, is very uncommon. It consists of ordinary gland tissue, in which the relative proportions of gland substance and interstitial tissue are the same as in the healthy mamma. The adenomata form rounded or oval masses, of slow growth, freely movable, and resemble in their clinical characters the fibro-adenomatous tumour, which will next be described, so that it is only on microscopic examination that their true histological nature is ascertained. There is no reason to separate them clinically from the adeno-fibroma.

b. **Adeno-fibroma.**—These tumours were formerly known as the *chronic mammary tumour*, and are now very often termed *adenoid tumours*, which term would include the preceding group, from which they cannot be clinically differentiated. The tumours form firm lobulated masses, of a greyish white colour, somewhat foliated in structure, surrounded by a capsule of fibrous tissue, which is imperfect at one spot, through which the vessels enter and by which they are connected to the rest of the gland structure. Microscopically they consist of small clusters of acini, lined by cubical epithelium, and surrounded by a considerable amount of firm connective tissue. The glandular spaces may retain their resemblance in shape to normal acini, but are more often flattened, slit-like cavities. In some cases the connective tissue between the acini is so considerable that the tumour appears to consist almost entirely of fibrous tissue; but when examined microscopically it is found to contain glandular tissue. These tumours are believed by some to be true fibromata, and the acinous spaces lined with epithelium are regarded as merely the original gland structure, included in the developing fibrous tissue. The more general view is that these acinous spaces are of new formation, and that the glandular tissue plays an important part in the structure of these tumours, which are therefore regarded as adeno-fibromata.

Symptoms.—These tumours generally occur in young women under the age of thirty, and are often associated with a neurotic temperament, and sometimes connected with some uterine irritation. They are often attributed to a slight blow, and this may be the exciting cause in some cases. A more probable cause appears to be that they are little isolated masses of embryonic tissue, which when the breast enlarges and undergoes more active life after puberty, are induced to take on active growth and develop into tumours. These tumours are generally single and occur only in one breast, generally superficially. They form a hard, smooth or slightly nodulated lump, which is freely movable, but often attached to the rest of the gland tissue by a sort of pedicle. They can be pushed back into the gland tissue, and, on the other hand, when superficial, can be raised from the rest of the breast without causing any retraction of the nipple. They grow slowly, and often, after attaining a certain size, remain stationary. As a rule they are not painful, but sometimes in neurotic subjects they are the seat of intense neuralgic pain.

The **diagnosis** from scirrhus can generally be made by noting the age of the patient, the better defined outline and greater mobility, the absence of any dimpling of the skin or retraction of the nipple, the non-implication of the axillary glands, and the slow growth of the tumour. From chronic mastitis they may be distinguished by their less intimate association with the gland tissue, and their greater mobility upon it.

Treatment.—Though these tumours are innocent growths, and as a rule give rise to little inconvenience and annoyance, their removal should be advised, as their presence is always likely to prey upon the mind of the patient, from a fear of cancer, and because they may attain such a size as to produce actual deformity. They may be removed by a single incision radiating from the nipple, when they can usually be shelled out. To avoid the deformity of a scar, it has been proposed to raise the breast and make the incision at its lower margin, where the future scar would not be seen. The breast is pulled forwards and the tumour removed from behind.

c. **Adeno-sarcoma.**—The so-called *adeno-sarcoma* are also frequently named *soft adeno-fibroma*, and probably this is a better appellation, since the introduction of the word *sarcoma* is likely to mislead as regards their clinical characteristics. They differ mainly from the ordinary adeno-fibroma in their softer consistence and in their more rapid growth, and indeed may be, and are, frequently developed from the adeno-fibroma, which, after remaining fairly quiescent, increasing only slowly in growth for a certain time, may suddenly take on active growth, increase rapidly, and become softer in consistence. They are then said to be *adeno-sarcomata*. Microscopically the difference in structure between the two classes of tumours is in the interstitial tissue which connects the acini together. In the adeno-sarcoma it is abundant and embryonic in character, consisting of a mixture of round and spindle cells, with imperfectly developed fibrous tissue. In other cases there are seen to be stellate cells with long processes, forming an open network, which gives to the growth a myxomatous character. These tumours are generally met with in rather older women than the adeno-fibroma, generally between thirty-five and forty. They grow with considerable rapidity, but remain strictly encapsuled and perfectly movable. They do not infiltrate the gland tissue, but cause its atrophy from pressure. They are painless and do not implicate the lymphatic glands.

The tumour itself is nodulated, soft, and semi-elastic ; the skin over it, as it reaches the surface, becomes thinned, but remains otherwise healthy, and can be moved over the growth. Upon making a section of the tumour after removal, it presents a soft, jelly-like, succulent appearance, which has been compared to sago jelly. It is often studded with cysts, and presents patches of mucoid softening.

Treatment.—These tumours should at once be removed. Being distinctly encapsuled, there is no difficulty in dissecting them out, and they show no disposition to recur. Between the two types of adeno-fibroma and adeno-sarcoma a large series of gradations are met with, all consisting of glandular elements and some form of connective tissue in varying proportions.

d. **Adeno-cystoma.**—These tumours, which were originally described by Brodie as sero-cystic tumours of the breast, are another form of adenomata, which is characterised by the formation of intra-cystic growths within cysts, formed by the dilatation of the acini of an adenomatous tumour. The cysts vary in size, from a pin's head to very considerable dimensions, one or two cysts generally preponderating over the rest. Within the cysts are lobulated, fibro-papillomatous intra-cystic growths, which spring from the walls of the cyst and vary much in size, sometimes attaining such a magnitude that they completely fill the parent cyst and give it the appearance of a solid tumour. These papillary growths are caused by a proliferation of the intra-acinous tissue, which grows into the cavity, pushing the epithelial lining of the dilated acinus or duct before it ; they are therefore covered with cuboidal or columnar epithelium. They present a knobbed tuberous appearance, not unlike a cauliflower, and are exceedingly vascular (fig. 405). They occasionally bleed, and the fluid in the cysts, which was originally clear, then becomes variously coloured from the presence of blood pigments. They are usually encapsuled, and as they grow cause atrophy of the structures around them. As they reach the surface of the body, the skin becomes thinned and stretched over them, and eventually gives way; the capsule perforates, and a fungous mass—that is, the intra-cystic growth—sprouts through. This bleeds freely, grows rapidly, becomes offensive, and presents all the characteristics of a fungating mass of malignant disease. It can, however, be distinguished from it by the fact that the skin around the perforation, though thinned, is perfectly natural and not infiltrated by any new growth.

These tumours are generally found to occur in women between the age of thirty and forty, and as a rule at an earlier period of life than carcinoma. They usually commence as firm, hard tumours (adenofibroma), which grow slowly at first and then increase more rapidly in size: one or more cysts taking on active growth until they may attain an enormous size. They are soft, and generally fluctuation can be detected in places over the most prominent cysts. They are lobulated and irregular in outline, owing to the projection of cysts. They are freely movable on surrounding structures, and the skin is not adherent to them. They are usually painless; there is no enlargement of the axillary glands and no retraction of the nipple. After fungation has occurred the growth is very rapid, and they speedily prove fatal from hæmorrhage and exhaustion, if not removed.

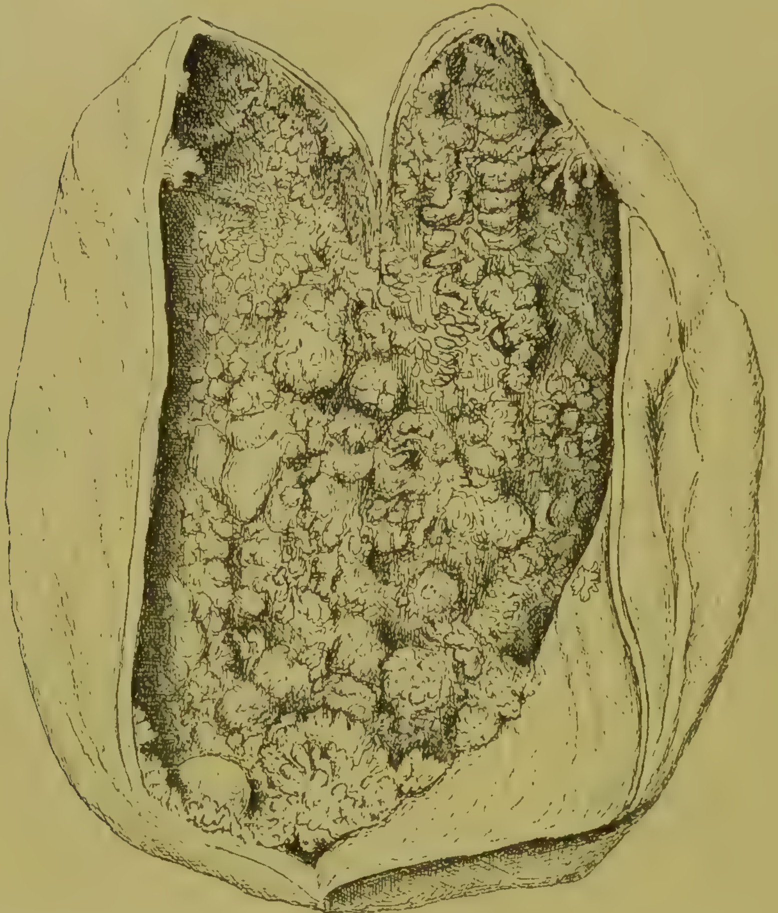

FIG. 405.—Large cyst of the breast, with papillomatous growths from its lining membrane. (From the Museum of St. George's Hospital.)

The **treatment** consists in excision. In the early stages the tumour may be enucleated without removing the breast, but later on when it has attained a considerable size the whole breast will have to be excised. After removal it has no tendency to return.

Duct papilloma.—It is convenient in this situation to mention a tumour which goes under the name of *duct papilloma*, and which resembles the tumours which have just been described in the fact that the disease is characterised by the appearance of papillomatous outgrowths upon the interior of some pre-existing cavity. Occasionally women will complain of a little discharge of blood-stained serum from the nipple, and upon examination this organ will be noticed to be unduly prominent, and a little swelling may be detected under the areola at one point. If an incision is made, a little cavity will be exposed, which is a dilated milk duct, in which will be seen a soft papillomatous growth. This condition merits its chief importance from the fact that it is often the precursor of a disease which will subsequently be described, and which is known by the name of *duct cancer*. These tumours should therefore always be freely excised, and it will be necessary to sacrifice the nipple.

2. **Sarcoma.**—Sarcoma is not a common disease of the breast, many of the cases which were formerly classified as sarcoma belonging to the class of adeno-sarcoma or adeno-cystoma. The spindle-celled sarcoma, either consisting of the large or small celled variety, is the most common form met with; but the round-celled sarcoma is also not uncommon. Myeloid sarcoma has been said to occur in the breast; but it is very doubtful whether this really occurs, though in some cases large multinucleated cells have been found. Cystic degeneration from mucoid changes is exceedingly common in sarcoma of the breast; and extravasation of blood, which may also cause the formation of cysts, is not uncommon. On section a sarcoma of the breast in an early stage is usually found to be encapsuled, and will vary in appearance according to its nature and the changes it has undergone. It may be white or rosy pink in colour, and firm in consistence; or it may be dark and studded with hæmorrhages, and soft and converted into a jelly-like mass. The fluid in the cysts is usually thick and viscid, and may be straw-coloured, brownish from altered blood, or it may be almost pure blood.

Symptoms.—The disease usually occurs about the age of forty, and the patient is generally otherwise in good health. Sometimes there is the history of a small tumour which has existed in the breast for years without causing any inconvenience, and this suddenly without assignable reason has begun to grow rapidly. It forms a firm lobulated tumour, which progressively increases; but it is not so hard or so freely movable as the adeno-fibroma. There is no retraction of the nipple, though it may be sunken from the prominence of the growth. There is no puckering of the skin, which at first is natural, but later on, as the tumour grows, becomes thin, stretched, and congested, and minute extravasations of blood may take place into it. The glands in the axilla are not as a rule enlarged, though occasionally secondary growths take place in these bodies. As the tumour grows and cysts form, the lobulation of the growth becomes more marked, and prominent bosses may appear, in which fluctuation can be detected. The growth is rapid, and should pregnancy occur the rate of growth is alarming. When the tumour reaches the surface of the body, the skin gives way, fungation ensues, and a foul bleeding mass sprouts from a clean-cut hole in the skin, which is not infiltrated around.

The **diagnosis** of these cases from the adeno-cystoma is frequently impossible until a microscopic examination of the growth is made. The chief differential points of diagnosis are the rapidity of growth, the mobility, and the age of the patient; the adenomatous tumours generally appearing before the age of thirty-five, the sarcomatous after that age.

Treatment.—The treatment consists in removal of the breast at as early a period as possible. The disease, however, shows a great tendency to recur in situ or to disseminate itself in other parts of the body.

3. **Carcinoma** is a very common disease, which affects the breast primarily. Most frequently one breast only, but occasionally both may be affected.

Etiology.—Our knowledge of the causation of cancer of the breast is at present merely a matter of conjecture. It is far more common in the female than in the male, in the proportion of about one in the latter to a hundred in the former. It occurs more frequently in married women than in single, but then it must be remembered that the proportion of married women to single is greater. In married women it is met with oftener in those who have borne children than in those who are sterile. The condition is rare at the extremes of life, though essentially a disease of somewhat advanced life, the majority of cases occurring between the ages of thirty-five and fifty-five. Numerous causes have been assigned for this disease, among which the most common are heredity, injury, and the presence of some source of irritation. With regard to heredity as a cause of cancer there is considerable divergence of opinion. Formerly this view was much more strongly insisted upon than in the present day; but even now it cannot be doubted that certain families show a marked predilection to develop cancer. It may be that in some of these cases the tendency to cancer is explained by the relatives living in the same house or locality; for it has recently been abundantly proved that in certain districts cancer is much more likely to occur than in others, and that certain houses become in some way infected, so that individuals residing in them are prone to develop this condition. Injury is said to be another cause of cancer; and in examining patients afflicted with this disease it is exceedingly common to find that the individual gives the history of some blow or squeeze as the cause of her complaint. It is known that injury may induce malignant disease in other parts, and it is probably true also that it may be the starting point of the growth in the breast. The presence of some irritation from an antecedent condition is looked upon by many as a cause of cancer in the breast. It is an undoubted fact that irritation is a potent factor in the production of cancer elsewhere, as for example in the tongue from the irritation of a jagged tooth; in the lip from the constant irritation of a pipe; in the scrotum of the chimney sweep from the constant irritation of soot lodged in its rugæ, &c. Many extend the same view to cancer of the breast, and believe that this disease owes its origin in many cases to the irritation produced by damaged tissues, the result of inflammatory or other conditions. The matter is one, however, of conjecture only, and no proof has as yet been afforded, by statistics or otherwise, as to the real truth of the theory.

As regards the exciting cause of cancer, recently certain bodies have been described as having been found in connection with the epithelial cells of cancer. These are of the nature of protozoa, the lowest form of animal life, and are believed by some to be the direct cause of cancer.

The subject cannot, however, be considered in any way as proved, and many powerful arguments can be adduced against the theory.

Two distinct forms of cancer are met with in the breast: the *acinous*, commencing in the acini, and constituting the most common form of the disease; and *duct cancer*, which begins in connection with the ducts.

a. **Acinous carcinoma** begins as a proliferation of the epithelial cells of the acinus. The proliferated cells find their way through the walls of the acini, and speedily infiltrate the connective tissue spaces, and pass into the lymphatic channels, along which the disease in all probability spreads, until a considerable area of mammary tissue is implicated. In this a stroma is developed. The relative amount of stroma to cells will determine whether the cancer is hard or soft. In most there is a great tendency to the development of fibrous tissue in the centre of the growth, and this by its contraction leads to atrophy of the epithelial cells. Under these circumstances a hard tumour is formed, which is usually known by the name of *scirrhus*, and is the most common form in which cancer of the breast is met with. In other cases the fibrous tissue is more scanty, and then the cells are more abundant, larger and plumper, and the whole growth proportionately softer. This is known as the *encephaloid* or brain-like cancer, and between these two types any gradation of consistence may be found.

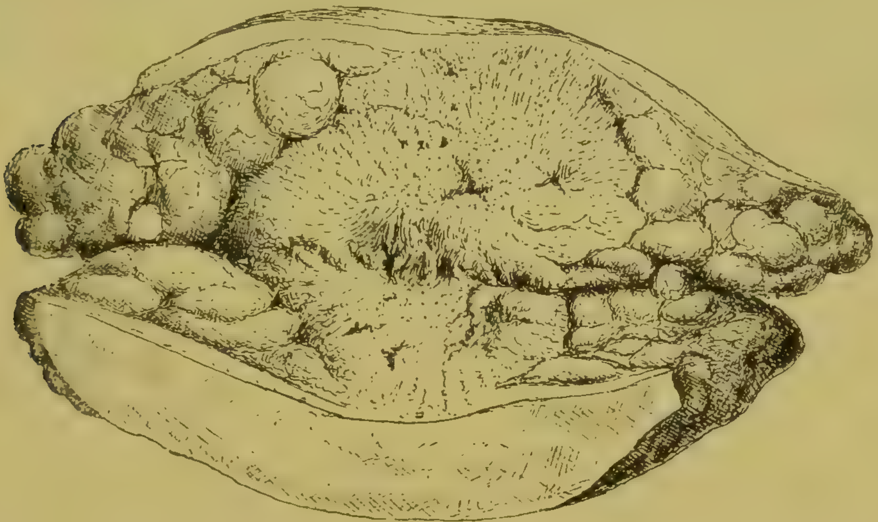

FIG. 406. – Scirrhus of the breast. (From the Museum of St. George's Hospital.)

The subsequent progress of a case of cancer of the breast after its formation is its increase by infiltration of surrounding parts, and its tendency to spread along the lymphatic vessels to the nearest set of glands, which it secondarily implicates, or it may become disseminated in some internal organ or distant part. When a section is made of a scirrhous cancer of the breast, the appearances are characteristic (fig. 406). When it is cut across, the resistance to the knife is very marked, and often there is a creaking sound. The toughness is greatest in the centre of the growth, and shades off towards the margin. The cut surface is usually somewhat concave, of a yellowish grey, semi-transparent appearance, traversed by whitish bands of a more opaque character, and studded with minute yellow dots of degenerated tissue. It exudes on squeezing a thin milky juice, which is probably the altered secretion of the remains of the gland. The microscopic characters are those of ordinary scirrhus (page 256). At the centre of the tumour the growth consists of almost pure fibrous tissue, while at the periphery are large alveolar spaces, full of epithelioid cells, with only a scanty amount of connective tissue between them.

Symptoms.—In describing the symptoms of cancer of the breast, we shall first of all consider the symptoms of the ordinary or scirrhous form of the disease, and then briefly describe certain modifications of it which are occasionally met with. The first symptom which is usually noticed is that the patient discovers, often quite accidentally, that she has a lump in her breast. This has probably appeared without pain, though in some cases pain or an uneasy sensation in the breast has led to its discovery. Upon investigating the case a small hard tumour will be felt forming an intimate part of the gland structure, most frequently situated in the upper and outer part of the breast. Upon careful manipulation it will be found that its margin is not accurately defined, and that it is impossible to exactly locate the spot where the disease ceases and the healthy structures begin. If the tumour is near the surface of the breast, the skin will be seen to be dimpled, if it be tensed over the surface of the growth by the finger and thumb. This dimpling of the skin is produced by the contraction of the stroma of the tumour dragging on the suspensory ligaments passing from the breast to the skin. If the tumour is more deeply seated, this dimpling is not noticeable in the early stages of the disease. If it is situated in the neighbourhood of the nipple, retraction of this part is an early symptom; but if it is more remote, retraction of the nipple may not occur till later, or may be absent altogether. The nature of the hardness is very characteristic, and is described as of a 'stony' character, and this well expresses it, and is especially perceptible when the tumour is comparatively superficial; when it is more deeply seated, the stony hardness is obscured by the overlying gland tissue. In the early stages the pain is not as a rule great, but the patient may complain of a sudden stabbing pain shooting through the organ. The breast is not enlarged; in fact, in many instances it appears to be smaller than the one on the opposite side from the contraction of the stroma of the growth. As the tumour increases, it invades the gland and is more fixed, from becoming adherent to the fascia covering the pectoral muscle. The skin is soon implicated; it becomes more and more fixed to the tumour, and eventually infiltrated by the growth; it is at first thickened and brawny, and then is purplish or red, and finally gives way. As soon as the skin is affected, the pain is very acute. It is of a peculiar lancinating character; is increased by handling the tumour or by pressure, from the corset or otherwise; is often intermittent and of a neuralgic character, radiating to the shoulder and down the arm. After the disease has existed some time, enlargement of the axillary glands will be felt; those running along the edge of the pectoralis major being first affected, and then extending, till all the glands in the axilla are involved. From these the disease may spread to the glands in the subclavian triangle of the neck. In some cases the mediastinal glands may also be affected. Ulceration of the skin usually begins as a crack or fissure, which discharges a little serous fluid, that dries and forms a scab. Under this, ulceration sets in, and a typical scirrhous ulcer is formed. The ulcer is excavated and surrounded by an indurated margin, which often forms a very considerable elevation. The surface of the ulcer is generally sloughy, and there is a constant discharge of an offensive sanious fluid. While these changes are going on at the surface, the tumour is extending more deeply, and, after implicating the pectoral fascia, invades the muscle and becomes more and more fixed, especially when the arm is extended, so that the muscle is tensed. The growth may also invade the wall of the chest, and passing through it, may involve the pleura. As the glands in the axilla become enlarged, they press upon the axillary vein, causing obstruction and œdema of the arm ; and on the cords of the brachial plexus, causing intense pain in the upper extremity.

In the later stages of the disease a condition of general cachexia is set up. The patient emaciates, loses her appetite, becomes sallow and wan, and eventually dies from exhaustion, induced by pain, want of sleep, and repeated hæmorrhage ; or from a condition of septic poisoning, from the absorption of poisons formed in the cancerous growth. In other cases secondary deposits take place in other parts of the body ; the liver, the pleura, and the bones being the parts most usually affected.

The above are the characters of an ordinary case of scirrhous cancer of the breast. It will be now necessary to say a word or two on various modifications to which the acinous form of cancer is liable.

Encephaloid cancer.—This, as pointed out above, is merely a modification of acinous cancer, in which the proportion of stroma to cells is different from what it is in the form of the disease which has just been described. In these tumours the amount of stroma is much less, and the number and size of the cells is proportionately larger. The result of this is that the whole tumour is softer and is more rapid in its growth. No definite line can, however, be drawn between the hard and soft forms, for between the two every gradation of consistence may be found.

The disease is met with as a soft, rapidly growing tumour, infiltrating the whole breast, which becomes large and prominent. There is no dimpling of the skin nor retraction of the nipple in a typical case, but the disease rapidly reaches the surface, and implicates the skin, which gives way, and a large fungous protrusion takes place, which often bleeds furiously on account of its great vascularity, and rapidly destroys the patient's life from exhaustion. This soft form of cancer is liable to be followed by secondary deposits in the viscera, and by glandular implication at a much earlier date than the scirrhous form. In fact, it runs a very much more rapid course than the hard variety.

Atrophic scirrhus.—A very different form of cancer of the breast from the preceding is the condition which is known as *atrophic scirrhus*, which is not uncommonly met with in the breasts of old women. In these cases the nodule of cancer never attains a large size, but gradually causes the gland tissue to shrivel up and disappear. This is due to an excessive contraction of the fibrous stroma of the growth, which by its contraction presses on and destroys the cellular elements. The skin over the tumour generally gives way after a time, and forms a small ulcer which slowly spreads. Patients suffering from this form of cancer have been known to live for many years, and eventually die of some other malady. Sometimes, however, secondary growths appear in the viscera, or the bones, and these grow rapidly and destroy the patient. The lymphatic glands are not implicated at nearly so early a period. The appearance of these tumours is very characteristic. The breast is small and shrivelled ; the nipple deeply retracted ; the skin adherent to the surface of the growth, and often presenting an ulcerated surface, covered by a scab. The breast is often closely fixed to the underlying tissues. It is almost painless, and the general health does not suffer.

Scirrhus en cuirasse.—A peculiar form of scirrhus is sometimes met with in which the disease, beginning in the gland tissues, implicates the skin, and seems to exert all its influence on disseminating itself in this structure, the disease in the breast not making great inroads, and, in fact, in some cases undergoing an atrophying process. The skin covering the breast, and for some distance around, becomes thickened and indurated, so that it is impossible to wrinkle it. The pores become enlarged, so as to be visible to the naked eye, and give it the appearance of being covered all over with pin-holes. This, from its resemblance to the skin of a pig, is known as 'pigskin.' There is at first no discolouration, and this may continue throughout, but after a time the skin may become discoloured, brownish, or purple. Its surface may become covered with crusts or scabs, from the drying of an abundant secretion, which takes place from the surface, but there is no ulceration. The disease may extend until the whole of the front of the chest is covered with a hard, leathery, indurated skin, and during the whole of this process there has been no extension of the disease in the breast. It is very chronic, and is due to an extension of the disease along the cutaneous lymphatics, but, in spite of this, the lymphatic glands only become infected at a late period of the disease, and the general health is not nearly so early affected as in the ordinary form of cancer of the breast. In fact, it is no uncommon thing to see a woman who has been suffering from cancer en cuirasse, even for years, stout, red-faced, and apparently in the enjoyment of perfect health.

b. **Duct cancer.**—The other form of cancer which attacks the breast takes its origin in connection with the ducts of the gland. The disease begins as papillomatous growths in a duct (page 1089). These increase and fill the cavity in which they originate, and then, finding their way through the wall of the duct, spread as an infective growth. These papillary growths are very vascular, and are covered with columnar epithelium, and the disease may be regarded as a columnar carcinoma, beginning in the columnar epithelium of the ducts, and the disease spreads by the advance of their proliferated epithelium into surrounding structures. To the naked eye the growth bears some resemblance to soft cancer, but differs from it in presenting numerous minute cystic cavities, partly formed by the dilatation and obstruction of the ducts, and partly due to the coalescence of papillary processes enclosing spaces. These cystic cavities are often filled with altered blood, from giving way of the vessels of the vascular papillæ. Microscopically the tumour consists of spaces lined by columnar epithelium, held together by a fibrous stroma, and containing villous processes, also covered by columnar epithelium. Duct cancer usually occurs in the breasts of elderly females. It is characterised at first by the sign of duct papilloma, a bloody discharge from the nipple. This is followed by the appearance of a small tumour, generally towards the centre of the breast, beneath the areola. The swelling is rounded, and the skin over it often dusky red. The tumour as a rule grows slowly and does not often attain a large size. It is usually moderately hard, but may sometimes present softish projections from it, like cysts. The nipple is not retracted, and the axillary glands are not always implicated. The disease is not so malignant as the acinous form, but local recurrence may take place after removal. In many cases the diagnosis can only be made by microscopic examination after removal, and in some instances the two diseases, spheroidal carcinoma and duct cancer, have been found associated in the same specimen.

Diagnosis of cancer of the breast.—When a cancer of the breast is at all advanced, the diagnosis is in most cases easy; the marked hardness, the ill-defined, somewhat square, outline, the implication of the skin, and the fixity of the tumour, sufficiently indicate the nature of the tumour. The disease with which it is most likely to be confounded is chronic interstitial mastitis, but in these cases the whole of the breast tissue is involved; the skin is usually not puckered or adherent to the growth, and the axillary glands are not so likely to be affected, and, if enlarged, are not so hard as in cancer. Moreover, the breast will be found to be enlarged, instead of being contracted, as in the cancerous condition, and the other breast may show some indications of being affected by the same inflammatory condition. In some cases it may be very difficult to distinguish a chronic abscess or a very tense cyst from a cancer, but on examination elasticity or even deep fluctuation can be felt, and the centre is always less resistant than the margin, which is different from what is found in a tumour. If any doubt still exists it can be at once solved by the introduction of an exploring syringe.

From innocent tumours of an adenomatous type the diagnosis is comparatively easy; the defined outline, the mobility, and the non-implication of the skin, together with the age of the patient, is sufficient to establish a diagnosis. The diagnosis of a soft encephaloid carcinoma from a sarcoma or adeno-sarcoma is not always possible until after removal and examination by the microscope, although in the early stages the latter are more circumscribed. If there is any doubt about the nature of a tumour of the breast, it can be at once settled by an exploratory incision, and this should be at once advised, obtaining from the patient at the same time permission to carry out any further operative measures which shall be deemed necessary. Considering the uncertainty which exists about the diagnosis of many of the tumours of the breast, it is a good plan for the surgeon to habituate himself as a routine practice to cut into all tumours of the breast before proceeding to remove the organ. Cases have constantly occurred where a breast has been removed for some innocent tumour, chronic abscess, or such like, and these mistakes might easily be averted by following this simple rule.

Treatment.—Many different plans of treating cancer of the breast have been advocated, but there is only one method on which any reliance can be placed, and that is removal by the knife. Powerful caustics, including the actual cautery and galvano-cautery, have been employed at various times, but they are scarcely likely to be used in the future, on account of the intense pain and the sepsis which attend their employment. Recently an attempt has been made to destroy the growth by passing a powerful faradic current through it, in the hope that it may be possible to destroy the vitality of the cancer cells by this means.[1] But at present our knowledge on this subject is very meagre. The injection of Coley's fluid (see page 250) has also been tried in cases of carcinoma of the breast, especially in those cases where the disease is too far advanced to be removable by the knife, but so far unsatisfactorily. This plan of treatment would appear to be more suited to cases of sarcoma than carcinoma. The only treatment, therefore, of cancer of the breast which needs our consideration is removal of the disease by the knife. It is scarcely necessary to say that this removal should be done at as early a period as possible, for it is not every case of cancer of the breast that is suited to treatment by operation, and the great majority of cases which are unsuited are those in which the disease has existed for so long a time that its entire removal is impossible. The first question which the surgeon should ask himself in considering the desirability of removing a cancer of the breast or not, is: Can the whole of the disease be entirely removed or not? If the answer is in the negative, under no circumstances whatever is an operation admissible, except as a palliative measure to relieve pain, or annoyance from the fœtor of the discharge. All cases, therefore, where there is any evidence of secondary growths elsewhere; where the skin is extensively implicated, as in cancer en cuirasse—because the lymphatic affection extends far beyond the part apparently affected; where the glands in the subclavian triangle are enlarged—because, though it is possible to remove these glands, the connecting lymphatics between them and the axillary glands cannot be got rid of; where the tumour is adherent to the thoracic wall; where there is considerable œdema and neuralgia down the arm; and where there is an extensively fungating tumour with marked constitutional cachexia, no operation is admissible. An operation for the removal of a cancerous breast must be as thorough and complete as possible. By this is meant that not only must the entire breast be removed, but also the skin over the affected area of the breast, and for a considerable distance around; the pectoral fascia, and perhaps even a superficial layer of the pectoralis major muscle; the lymphatic glands in the axilla, and the lymphatic tissue passing from the breast to the glands in the axilla. To insure this latter object the surgeon should remove the whole in one piece, and by doing this he will find that he will gain assistance in clearing out the axilla, as the weight of the breast tends to drag down its contents.

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[1] *B.M.J.* 1889. (Inglis Parsons.)

We must consider these points a little more in detail: (1) The whole of the breast must be removed. The breast is a much more extensive organ than was formerly supposed, and, in addition to the main mass, consists at its periphery of many outlying lobules, which may extend inwards nearly to the sternum and upwards to the clavicle. All these lobules must be scrupulously removed, since by leaving them they may lead to recurrence. Stiles of Edinburgh has introduced a method by which in a very short time it can be ascertained whether any lobules of the breast have been cut through in the removal and, therefore, parts of breast tissue left behind. The breast immediately after removal is well washed; then soaked in a 5 per cent. nitric acid solution for five to ten minutes, and again washed; sections of acini and nodules of disease will appear as white points in the fibrous stroma, which has become translucent and gelatinous. (2) The skin over the affected area of the breast and for some distance around must be removed. This is because a system of lymphatics passes from the plexuses around the lobules of the breast through the suspensory ligaments to the lymphatic plexuses in the skin, and if these are not all removed, portions of lymphatic vessels which have already become infected may be left behind, and may cause a recurrence of the disease. It must be well known to surgeons who watched the incomplete operations of former days that in numberless cases in which recurrence took place the disease did not recur in the scar, but as a nodule in the skin, some little distance from the scar. This was no doubt due to the fact that an infected skin lymphatic had been left behind. In removing a cancerous breast the surgeon's first thoughts should be to remove the skin sufficiently wide of the affected area; his second thoughts, to leaving sufficient skin to enable him to bring the cut surfaces together. If this cannot be done, an open wound must be left, which may be closed by skin grafts. The nipple must in all cases be removed, since the greater part of the lymphatics of the breast course in the first instance to this structure. (3) The pectoral fascia must be removed, not only because the deeper lobules of the breast sometimes penetrate this structure, but also because the lymphatics of the breast are largely carried to the axillary glands by lymphatics situated in the fascia; by not removing this structure it is easy to understand that infected lymphatics may be left behind. Some surgeons believe that in order to remove this fascia thoroughly, a thin layer of the great pectoral muscle should be removed with it. (4) The axillary lymphatic glands and the fascia and fat running from the margin of the breast to the glands should be removed. It is now a well-recognised fact that the axillary glands may be infected before any enlargement has taken place in them, and therefore the surgeon, even though he introduces his finger into the axilla, and is unable to feel any enlargement of the lymphatic glands, cannot be sure that they are not affected, and therefore he affords his patient a better chance of non-recurrence by in every case 'clearing out' the axilla.

Amputation of the breast.—The operation of removal of the breast for cancer is performed as follows: the patient having been previously prepared, and the axilla shaved, is laid on her back, with the arm on the affected side held at right angles to the trunk. The surgeon first makes an exploratory incision, cutting well into the tumour, so that he can expose the cut surface of the growth. In the event of his diagnosis having proved right, he discards the scalpel he has used, and with another makes his first incisions. These must vary somewhat, but are usually carried in a semicircular manner above and below the prominence of breast almost from the sternum to the centre of the axilla. It is usually recommended that the lower incision should be made first, so that the view of the surgeon should not be interfered with by the blood running downwards from the upper incision while he is making his lower. The matter is, however, one of very little importance. The incisions should be carried into the subcutaneous fat. The surgeon now dissects up the skin with a little fat from the underlying tissues, almost as far upwards as the clavicle: inwards as far as the sternum, and downwards well below the lower boundary of the breast. At the sternum he exposes the fibres of the pectoralis major muscle, and, gradually dissecting outwards, detaches the breast and pectoral fascia from the muscle underneath or, if he considers it necessary, removes a thin stratum of muscular fibres also. Vessels as they bleed are at once secured with forci-pressure forceps by an assistant. As the surgeon nears the free anterior border of the muscle, he must take care to keep close to the muscle and clear it thoroughly. If the tumour is adherent to the fascia, and the fascia to the muscle beneath, the whole of the sternal portion of the muscle should be removed. This should be done at once, as it facilitates the subsequent clearing of the axilla, by separating the origin of the muscle from the costal cartilages and sternum, and then turning the muscle outwards, and securing the vessels which enter its under surface, dividing its tendon of insertion close to the humerus. If the surgeon determines to preserve the pectoralis major, the clearing out of the axilla is now proceeded with. The breast is not detached, but is left hanging by the connective-tissue surroundings, and by its weight pulls down the contents of the axilla, and so facilitates proceedings. The axillary vein is first defined and cleared by the fingers and an elevator up to the apex of the axilla, the pectoralis major being raised by an assistant with a retractor. Any vessels which are seen passing across the space must be included between two pair of forci-pressure forceps and then divided between them. It is desirable to try and save the large subscapular vessels, if possible. When the apex of the space is reached all fat and glands must be carefully removed, and then the whole axilla cleared by separating the tissues along the inner and posterior walls, so that when the proceeding is completed the axilla is cleared of all its contents but the main vessels and nerves. All vessels which have been seized with clips or are bleeding must be ligatured, and the surgeon should not be satisfied until all bleeding points, however small, are secured. The extensive wound is now well irrigated; a small incision is made in the most dependent part of the axilla, through which a large drainage tube is inserted for twenty-four or forty-eight hours, and, the arm having been brought down to the side, the edges of the skin are brought together. The plan which I usually adopt in doing this is to put in two, three, or more interrupted sutures of silkworm gut, which act as mainstays, and then sew up the whole length of the wound with a continuous horsehair suture. If there is any tension on the edges of the wound a few button sutures (fig. 15) are also inserted. The wound is dressed in the usual way, with plenty of wool, so that firm uniform pressure may be made.

The wound should be dressed on the second day and the drainage tube removed. It will not then require dressing till the twelfth or fourteenth day, when the wound will be found to be healed, and the sutures may be removed. It is well to support the edges of the wound for some time longer with strapping, so as to prevent the cicatrix, which is still soft, from giving.

Some surgeons are in the habit of advocating and practising still more extensive operations in these cases. Of these Halsted's operation may be regarded as a type. He removes the whole of the skin covering the breast; the whole of the great pectoral muscle; the fascia beneath it, and the fascia in front of and behind the lesser pectoral. In order to do this he divides the lesser pectoral muscle. He also removes the loose connective tissue, the fat, and all the structures, except main vessels and nerves in the axilla, up to the clavicle, cleaning the vessels by dissection with a sharp knife. The whole of this is removed in one continuous mass. The cavity is brought together as far as possible with a purse-string suture, and the rest of the wound allowed to heal slowly by granulation or covered with skin-grafts. The results obtained by this operation are no doubt very satisfactory as regards the non-recurrence of the disease, and it is said that the removal of one pectoral muscle and the division of the other does not materially impair the movements of the upper extremity; but the operation is a very severe one, and is attended with a considerable amount of shock, and it seems, at all events at present, doubtful whether it is right and necessary to proceed to so severe an operation in every case of cancer of the breast, or whether it is not better to reserve such extensive operations as these for cases in which the skin or the pectoral muscle is extensively involved. The matter at the present time is *sub judice*, and we must wait for more extensive experience before it can be finally settled.

In atrophic cancer some difference of opinion exists as to the propriety of removing the breast. My own feeling is in favour of leaving it alone; the disease is exceedingly chronic, is not attended with much pain or discomfort, and in many cases the patient dies of some other disease. Moreover, it is a well-recognised fact that in many cases where an atrophying scirrhus is removed, it returns rapidly, and in a far more active form, and speedily destroys the life of the patient.

In cases of duct cancer it is usually wiser to remove the whole breast, if the diagnosis of cancer is thoroughly established, but as in these cases it is almost impossible to distinguish between duct papilloma and duct cancer in its early stage, except by microscopic examination, it is justifiable in a doubtful case to excise first the affected lobule, and subject it to microscopic examination; if the results of this examination show that the disease has perforated the wall of the duct, and is infiltrating the surrounding tissues, excision of the whole breast should at once be performed. It appears, however, unnecessary in these cases to interfere with the glands in the axilla.

Cases unfit for the ordinary operation of removal of the breast.—In speaking of the cases unfit for operation, it was stated that when there was extensive œdema, and pain in the arm from involvement of the axillary vessels and nerves, no operation should be performed. It must be mentioned, however, that in cases of recurrent cancer of the axilla, associated with great œdema, and excessive pain in the arm, it has been proposed by Berger to remove the whole of the upper limb with the scapula. And in those cases where the sufferings of the patient are very great the operation is justifiable, provided the glands at the root of the neck are not extensively implicated; but it is only in extreme cases that the operation is called for.

Recently it has been proposed by Beatson of Edinburgh to perform the operation of oöphorectomy in cases of inoperable cancer, and combine with this the administration of thyroid extract, which he regards as a 'powerful lymphatic stimulant,' in the hope that the growth of the cancer might be arrested. Stanley Boyd has adopted this plan of treatment in seven cases, and states that, in his opinion, in two of these cases the beneficial effect was indubitable; in two, probable; and that there was no improvement, or very doubtful improvement, in three. He states that he considers that 'oöphorectomy is of value as a palliative operation.' With regard to the thyroid extract, he says that the cases in which he has tried it 'afford little evidence that it has any action upon the disease.'

Independently of these operations the treatment of inoperable cancer of the breast must consist in local applications to relieve pain and destroy fœtor; in the administration of narcotics to soothe the patient and promote sleep, and in careful dietary.

The most useful local applications are iodoform,[1] to which a small proportion of morphia is added; or the breast should be douched with a solution of sulphurous acid (1 in 40), or of chlorinated soda (one drachm of liq. sodæ chlorinatæ to one pint of water), and then covered with a strong solution of chloral hydrate, or a hemlock poultice. If bleeding occurs it can generally be arrested by soaking a pledget of wool in the liquor ferri perchloridi, and pressing it over the bleeding spot. When the pain becomes so great that it cannot be relieved by local measures, general remedies will have to be resorted to, and there can be no question that the most efficient, and at the same time the best, way of relieving pain is by the subcutaneous injection of morphia. This will have to be given in gradually increasing doses, and by its means the patient can be kept comparatively free from pain during the remaining days of her life. The diet should be light and nutritious, milk, beef-tea, and fish. Meat and stimulants are liable to increase the pain of cancer.

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[1] The 'iodoformum aromaticum,' which contains 2 per cent. of coumarin, should be used in order to destroy the offensive odour of the iodoform.

CHAPTER XVIII

DEFORMITIES

Lateral curvature of the spine: scoliosis.—This deformity, though in rare instances a congenital, is usually an acquired condition, and is not, as its name would seem to imply, a simple curve of the spine to one side or the other, for accompanying this curvature there is a certain amount of axial rotation of the bodies of the vertebræ on each other.

Etiology.—In considering the causation of lateral curvature it must be borne in mind that the spine is a flexible column which is kept straight by muscular action, the muscles on the two sides of the body acting equally. It is therefore predisposed to by weakness of the spinal muscles, and is brought about, in the majority of cases, by the patient constantly assuming a faulty position. Such positions as standing 'at ease;' sitting in a lounging position, with the legs crossed; a faulty position in writing at a low desk, with one shoulder higher than the other; and habitually carrying a weight on one arm, as in a nursemaid carrying a child, are all causes which bring about a lateral deviation of the spine when the muscles are weakened or exhausted. Other causes are, however, concerned in the production of this disease, as inequality in the length of the lower extremities, which produces a tilting of the pelvis to one side, and as a result a compensatory curve in the spine. The alteration in the length of the limbs may be due to many causes: congenital imperfection, congenital unilateral dislocation of the hip, faulty ankylosis of the hip in a position of abduction or adduction, paralysis of the muscles of one limb, congenital or otherwise, valgus or genu valgum. Rickets is also another cause of lateral curvature, though more frequently in these cases the curve is antero-posterior. Finally, it may be caused by falling in of the chest wall, as the result of an old empyema; but in these cases there is not the same amount of rotation as in an ordinary case of scoliosis. The condition is most common in girls about the time of the onset of puberty, no doubt because they possess fewer opportunities of exercising their muscles than boys.

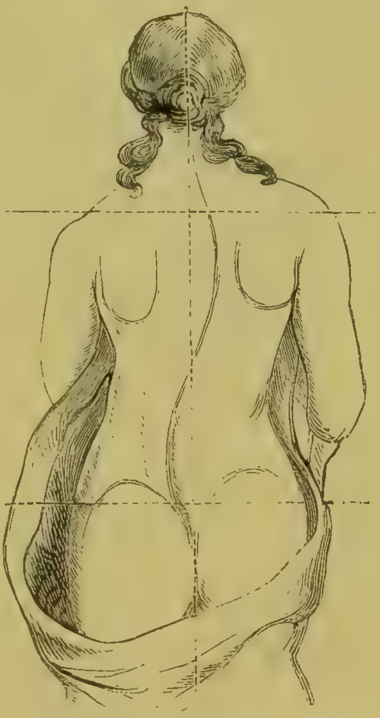

FIG. 407.—Lateral curvature of the spine. (From Erichsen's 'Surgery.')

Pathology.—In cases of lateral curvature the greatest curvature of the spine is in the dorsal region, and in the majority of cases has its convexity to the right, but in addition to this there is also a second curve in the lumbar region, which has its convexity in the opposite direction (fig. 407). Much has been written as to the manner in which these curves are produced. The explanation would, however, appear to be simple. If an individual stands on the right leg the pelvis is tilted, and the articular surface on the top of the sacrum faces to the left; this causes the lumbar curve, with its convexity in the same direction, and the dorsal curve, with its convexity in the opposite direction, is compensatory. If the muscles are weak and the faulty position habitually assumed, the deformity becomes permanent. The torsion appears to be caused by the muscles of the spine attempting to restore equilibrium, to a certain extent, by twisting the bodies of the vertebræ in the direction of the convexity of the curve. Their spinous processes are therefore directed towards the concavity, and their articular facets on the convex side of the curve are directed backwards. This causes the angles of the ribs to project backwards; while on the concave side of the curve the front of the chest projects. As the disease advances, changes in the shape of the bodies of the vertebræ take place. They are squeezed together on the concave side of the curve, and become somewhat wedge-shaped, the base of the wedge being directed to the convexity (fig. 408). When this has taken place the curvature becomes incurable. The ribs which are carried backwards on the convex side of the curve diverge from each other, while on the other side they are crowded together. The capacity of the chest is diminished and its movements impeded, so that respiration is materially interfered with.

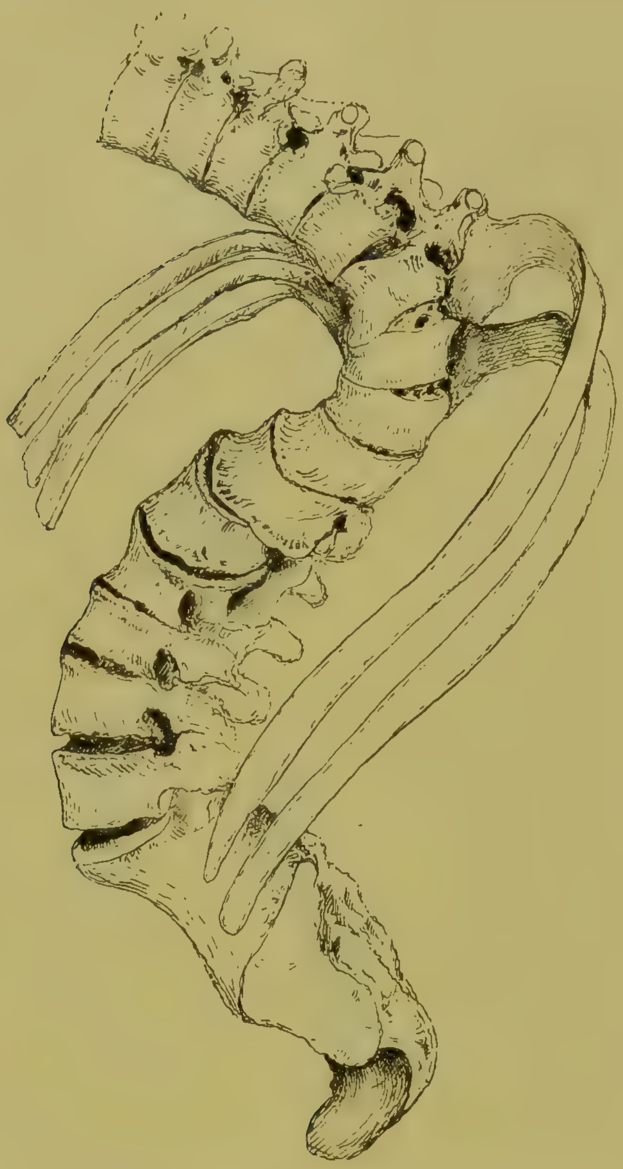

FIG. 408.—Bones in a case of lateral curvature of the spine. (From the Museum of St. George's Hospital.)

Symptoms.—In most cases of scoliosis the surgeon is consulted because it has been noticed that the shoulder or hip is 'growing out;' that is to say, for some alteration in the symmetry of the child. As a rule no pain is complained of, though in some cases pain of a rheumatic character is noticed, which may lead to this condition being mistaken for lumbago. The statement that the hip or shoulder is growing out should at once lead the surgeon to make a careful examination of the back.

The patient should be stripped to the waist, so that the crests of the ilia are fully exposed. The boots should be removed, and he should be placed with his back to the light, standing in the position of 'attention,' with the heels together and the hands hanging by the sides. At first little deformity may be visible, as the patient may do his best to assume a correct attitude, but as the muscles of the spine become tired the body assumes its ordinary position. It will be noted that the lobules of the ears are not on the same level; that the contour of the shoulders is not the same, but that one is on a higher level than the other; that one scapula, generally the right, projects more than the other, and that their apices are not on the same level; that the crest of the ilium on the same side is higher than its fellow, and that the loin on this side is hollow, while the opposite one is prominent. Upon taking an aniline pencil and marking the position of the tip of each spinous process as it is felt under the skin an outline of the curvature will be demonstrated. To ascertain how far the deformity is confirmed the surgeon should raise the patient, if a child, from the ground by placing the hands under the armpits; if the deformity disappears a favourable prognosis may be given. If the patient is too heavy to be raised in this way, he should be directed to stoop forwards with the heels together, the knees rigid, and the arms hanging loosely. If the back assumes a natural appearance and the spinous processes return to a straight line, there is sufficient evidence to prove that the deformity is not irremediable. Any causes of the deformity must now be looked for; the length of the two lower extremities must be compared; the hip joints examined for congenital displacement or ankylosis, the knees for genu valgum, the feet for valgus.

Treatment.—In treating lateral curvature of the spine, any obvious cause for this deformity must be removed; faulty ankylosis, genu valgum, or flat foot, must be treated by appropriate remedies; any irregularity in the length of the legs must be corrected by a cork sole and heel to the boot; any bad habit such as standing on one leg or carrying a heavy weight on one arm must be abandoned. Loss of tone of the system must be treated by tonics, fresh air, and attention to diet. The enfeebled muscles must be improved by massage and by regulated exercises, which must never be carried to fatigue and must be followed by periods of rest. The following is a summary of the plan of treatment. The patient must educate himself to maintain his body in a correct position. In order to do this he should accustom himself to the habit of correcting his position in the looking-glass until he learns what the correct position is. Standing, as far as possible, should be avoided, and when sitting he should always do so in a straight-backed chair; all lounging in an easy chair should be interdicted. Walking, playing games such as lawn tennis, hockey, &c., should be encouraged, so long as they are not carried to the point of fatigue. After these games the patient should lie down for half an hour or so to recuperate his muscles. In every case a thorough rest for at least a couple of hours on an inclined board in the supine position should be taken daily about midway between the hour of rising and going to bed. In writing, the paper should always be placed in a sloping position on the desk, so that the patient sits squarely to the table. In playing the piano the patient should be seated in a straight-backed chair, against which his back should rest. A trapeze should be erected in some easily accessible place, upon which the patient should be instructed to swing himself several times a day. Massage by an experienced rubber should be ordered every day, and the masseuse should have instructions to pay especial attention to the weak and stretched muscles. Finally, gymnastic exercises are a most efficient means of strengthening the weakened muscles. These must be carefully regulated to meet the requirements of each case, those exercises being employed which will exercise the weak muscles and counteract the deformity. Spinal jackets or supports, or even firm tightly fitting corsets, should never be allowed. They only do harm instead of good, by compressing the spinal muscles and causing them to atrophy from disuse, and therefore destroying the means by which the spine is naturally supported.

Kyphosis.—This condition is simply an exaggeration of the dorsal curve, and consists in an undue arching of the spine backwards. It occurs (1) in young children, usually as a result of rickets, and in these cases the whole of the spine from the occiput to the sacrum may present one great curve, with its convexity backwards; (2) in boys or girls from about the age of puberty to that of twenty. In these cases the curve usually shows itself most prominently in the upper dorsal region, and hence the name *round-shouldered* is given to this condition. It arises from persistent habits of stooping and is therefore very common in the myopic; (3) kyphosis may occur in adults in consequence of their following some occupation which necessitates constant stooping, as a tailor. It is also of late years of constant occurrence in bicycle riders, when it is known as *kitten-back*; (4) finally, it occurs in old men from senile decay.

It is in some cases accompanied by a compensatory curve in the lumbar region, which is known as *lordosis*.

It must be carefully distinguished from the antero-posterior curvature of the spine arising from caries of the bodies of the vertebræ, which has already been described (page 765). Here there is an absence of rigidity, at all events in the early stages, and of pain and tenderness on percussion. The disease, like lateral curvature, is mainly due to loss of tone and weakness of the spinal muscles, and therefore the treatment is the same: attention to the general health, systematic exercises, and massage.

Lordosis is a curving forwards of the spine in the lumbar region produced by an exaggeration of the lumbar curve. It must be looked upon more as a symptom than a disease, and arises as a compensatory curve to restore the equilibrium when from any cause its normal curves are altered. Thus, as we have just seen, it occurs in cases of kyphosis to compensate for the exaggerated dorsal curve backwards, and also in many cases of angular curvature in the upper part of the spine. In the same way it is produced to compensate for the tilting forwards of the pelvis in cases of hip joint disease when the thigh is flexed on the pelvis, and in cases of congenital or unreduced dislocation. It is also seen in cases of pseudo-hypertrophic paralysis, from the muscles being unable to keep the body erect; and in women with large abdomens; with uterine fibroids; and temporarily during pregnancy, owing to the increased weight tending to cause the upper part of the spine to be thrown backwards in order to maintain the erect position, and thus producing a compensatory curve in the lumbar region. Lordosis being a symptom, the treatment must be directed to overcoming the cause which gave rise to the condition.

Torticollis or **wry neck** is a deformity due to the actual shortening of one or more of the muscles of the neck on one side of the body. Probably in every case the sterno-mastoid is the first, as it is the principal, muscle affected, but subsequently other muscles, the trapezius, the platysma, the short muscles of the neck, and even the fascia, may be involved. In consequence of this shortening of the muscles, the head is drawn forwards and towards the shoulder of the affected side, and at the same time rotated so that the chin points to the opposite side.

Etiology.—Many causes have been assigned for this affection. It is said to be congenital, the result of defective development of the cervical vertebræ, malpositions in the uterus, or some congenital contraction of the sterno-mastoid muscle. But these causes are very rare; many of those cases which are noticed shortly after birth, and are classed as congenital, are in reality acquired, the injury which produces the condition being inflicted during parturition. By far the most common cause of torticollis, in my opinion, is injury to, probably rupture of, some of the fibres of the sterno-mastoid muscle in delivering the child in breech presentations. When the body of the child is born, the accoucheur endeavours to deliver the head by traction, and knowing that time is of importance, as the cord may be compressed by the head and the child's life endangered, he probably uses a little more force than he would otherwise do, and some of the fibres of the sterno-mastoid muscle give way. This is followed by an extravasation of blood into the sheath of the muscle, and when the infant is born a swelling is noticed, which used to go by the name of *congenital tumour of the sterno-mastoid muscle.* Inflammatory changes follow, and exudation takes place; this becomes organised and converted into scar tissue, which by its subsequent contraction causes actual shortening of the muscle, and so wry neck.

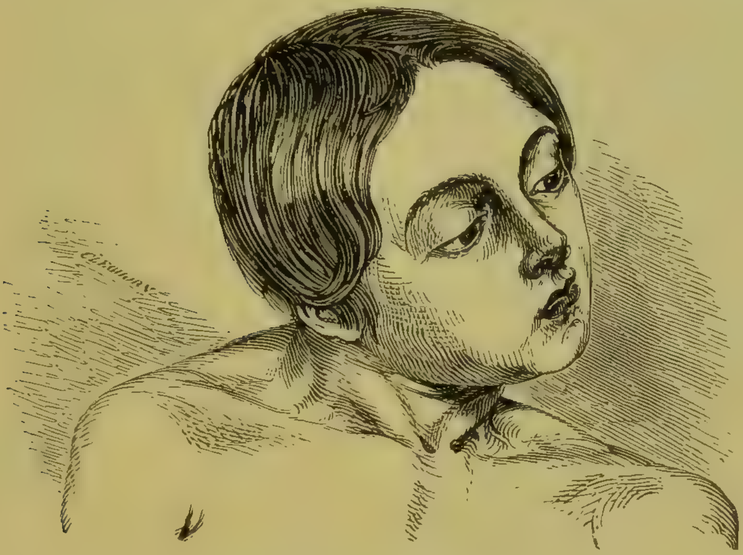

Fig. 409.—Wry neck.
(From 'A System of Surgery,' by Holmes and Hulke.)

Other causes of acquired wry neck are primary contraction of the cervical fascia, tuberculous glands in the neighbourhood of the muscle producing puckered cicatrices, and paralysis of the muscle on the opposite side. True wry neck must not be mistaken for the deformity produced by the contraction of the cicatrices of burns of the neck; nor for that produced by cervical caries; nor must it be confounded with spasmodic wry neck, which is a totally different condition, and is not attended by any shortening of the muscle, but by its spasmodic contraction, and is probably due to some central nerve lesion.

Symptoms and diagnosis.—The peculiar position of the head, inclined to the shoulder of the affected side, with the face turned in the opposite direction, is very marked (fig. 409), but is closely simulated by the condition which is often seen in cervical caries. In this latter disease, however, the movements of the head are restricted in every direction, whereas in torticollis they are only restricted in one, viz. in that in which the shortened muscle is put on the stretch. When this is done the tendons of origin of the muscle from the sternum and clavicle will be felt to stand out as rigid, tense bands. In cases of wry neck there is usually a want of symmetry in the two sides of the face (fig. 410), that side which corresponds with the shortened muscles being smaller and less developed than the other. This has induced some surgeons to believe that the disease must be due to some condition of the central nervous system which has produced this condition of deficient development. But there is no reason to think this; it may be readily accounted for by the circulation through the carotid vessels being interfered with from the position in which the head and neck are placed, leading to impaired nutrition.

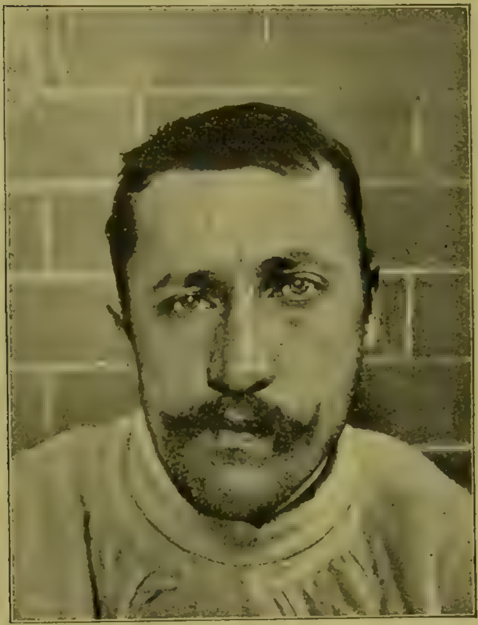

FIG. 410.—Asymmetry of the face, the result of torticollis. (From a photograph by G. H. Drake-Brockman.)

Treatment.—In the simplest and mildest forms of torticollis it may be possible to correct the deformity by manipulation, massage, and some form of elastic apparatus. But personally, as there is shortening of the muscle in these cases, I prefer to divide the muscle, or rather its tendons of origin. There are two ways in which this may be done, either by subcutaneous tenotomy or by the open method. The latter is to be preferred as being the more effectual and the less dangerous, if only proper antiseptic precautions are taken. The tendons of origin are freely exposed by a horizontal incision across the root of the neck and carefully divided. After their division, tense bands of fascia can generally be felt, and these should also be thoroughly divided until the head can be placed straight, or even pulled a little over to the opposite side. The wound is now sutured and dressed, and the head fixed in a corona plaster of Paris bandage (fig. 119) in a perfectly straight position for a fortnight. At the end of this time the wound is dressed, the stitches removed, and massage and manipulation applied daily, the corona being reapplied between each sitting. At the end of six weeks the fixation apparatus may be abandoned, but the child must be watched for some months, and the exercises continued.

Spasmodic wry neck.—This is a condition of tonic or clonic spasm of the muscles of the neck, due probably in most instances to some lesions of the nerve cells from which the nerves supplying the muscles take origin. It is generally unilateral, but may be bilateral. When the spasms are clonic, movements of a rotatory or nodding character are produced; when tonic, the head is fixed in an abnormal position by the spasmodically contracted muscles.

The **treatment** of these cases should in the first instance be general and medical, consisting in suitable hygienic and tonic measures, and these should be persevered with for some time before anything in the shape of operative interference is contemplated. When the sterno-mastoid and trapezius muscles are most in fault, removal of a portion of the spinal accessory nerve has been resorted to, in some instances with success. This is done by making an incision from the apex of the mastoid process, three inches in length, along the anterior border of the sterno-mastoid. The border of the muscle is defined, and the posterior belly of the digastric muscle sought for. The nerve will be found beneath this muscle, about two inches below the apex of the mastoid process. When the short muscles at the back of the neck are involved, it has been proposed to divide the posterior cervical nerves supplying these muscles. As the disease is usually due to some central lesion, both operations are frequently unsuccessful.

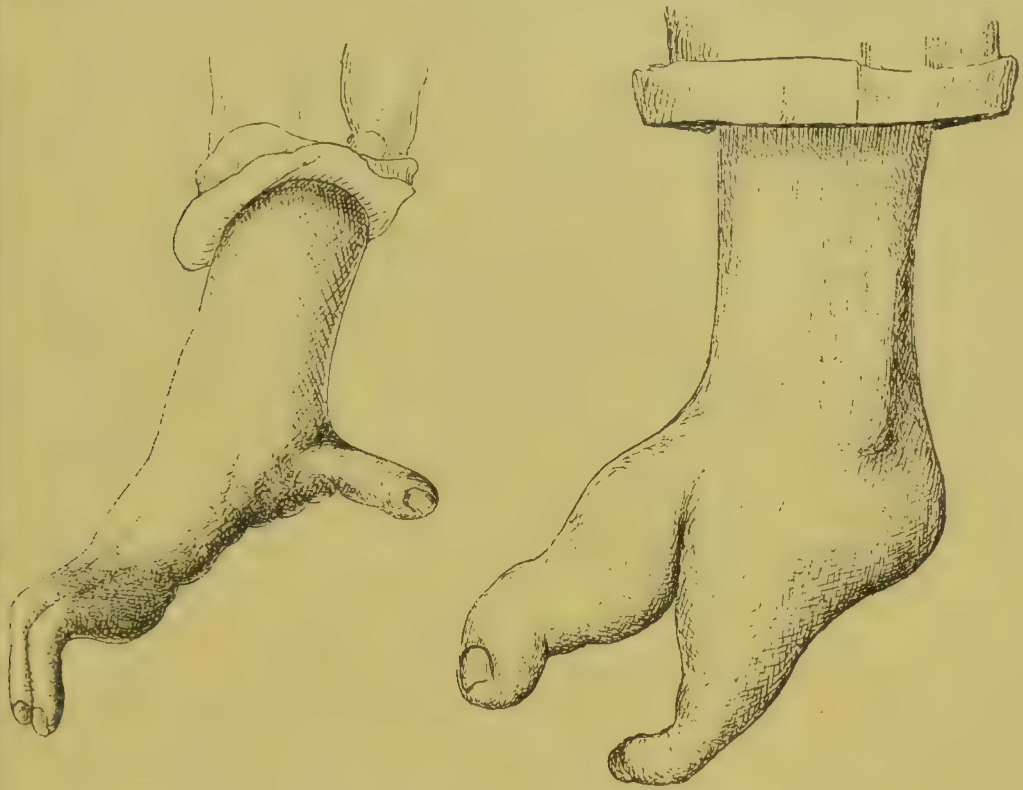

FIG. 411.—Deformity of the hand and foot. (From a cast in the Museum of St. George's Hospital.)

Deformities of the upper extremity, like deformities elsewhere, may be congenital or acquired. Among the most common forms of congenital deformity are supernumerary fingers or absence of one or more digits. The supernumerary fingers are usually either a second little finger or a second thumb, most commonly the former. The additional organ may be simply a little tag of skin, or may be a completely developed digit. In most cases the metacarpal bone is single, and two sets of phalanges spring from the one bone. The treatment consists in removing the supernumerary finger. One or more fingers may be absent. In its extreme form only the thumb and little finger may be present, and a similar condition may be present in the feet. The accompanying illustration, which was taken from a patient in St. George's Hospital many years ago, when I was Surgical Registrar, is a good illustration of this variety of deformity (fig. 411).

Club hand.—A similar deformity to club foot is occasionally, but rarely, found in the hand. The hand is usually rolled up into a ball in a condition of hyperflexion; but an opposite condition may be met with: the hand and fingers are over extended, and conjoined with this there is usually a certain amount of abduction or adduction. These cases are usually complicated with an imperfect development of the radius; either its lower extremity may be undeveloped, or there may be an absence of the whole bone.

Web fingers (*syndactylism*) is perhaps the most common congenital deformity of the hand. This consists in a union of two or more fingers by a fold or web of skin. In most cases this cutaneous fold is thick, so as to make the two fingers look like one. Sometimes it is thin and translucent, and the two fingers are clearly distinguishable from each other. Sometimes the union is confined to two fingers, sometimes it affects three, and at others all four fingers are joined together in this way. It may also vary in extent: sometimes it extends the whole length of the fingers, at others it may be a half or a third of their length, and in other cases the normal fold of the skin between the fingers is only slightly exaggerated.

The **treatment** is not always satisfactory. If the web is simply divided, reunion is certain to take place from cicatrisation spreading upwards from the angle formed by the divided surfaces. Some means must be taken to prevent this. The simplest plan is to insert a thick silver wire through the web at the point where the webbing commences, and then to twist it round the finger and leave it in situ until the perforation is soundly healed; the rest of the web can then be divided without any fear of reunion taking place. The points in this proceeding to bear in mind are to keep the parts aseptic and the ring of silver wire motionless until cicatrisation of the perforation has taken place; with these precautions success will generally attend this plan. If it should fail, Zeller's operation will generally succeed. It consists in raising small triangular flaps from between the

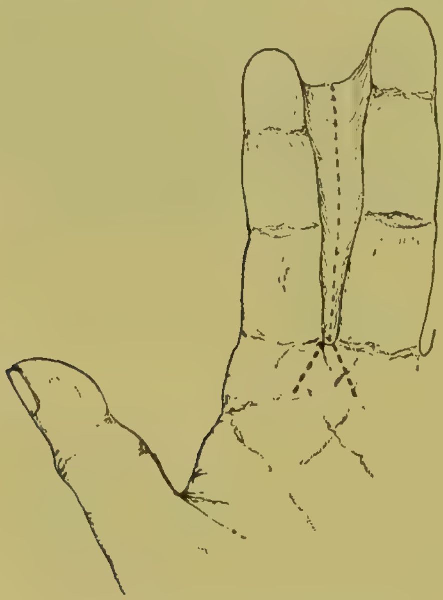

FIG. 412.—Zeller's operation for web fingers.

knuckles of the webbed fingers. The apex of the flap corresponds to the commencement of the web, and a flap must be made on both palmar and dorsal surfaces; they must be made thick and sufficiently long to come together without tension. The web is then divided and all the tissues between the two fingers severed up to the bases of the flaps, which are then carefully united by horsehair sutures (fig. 412).

Didot's operation, which consists in dissecting up two longitudinal flaps, one from the dorsal surface of one finger, and another from the palmar surface of the other, and folding them round so as to cover the raw surface of the finger to which they are attached, is not a very satisfactory operation, and the results are not always good. Moreover, in quite young children the parts are so small that the operation is difficult to perform.

Giant finger.—A congenital hypertrophy of one or more fingers is occasionally met with (fig. 413); the condition, however, is more common in the toes. It consists of a true hypertrophy, the structures of the finger or toe being normal, but in excess. The only treatment is removal.

Among **acquired deformities** of the upper extremity are deformities from burns, deformities of the hand from arthritis deformans, and hammer finger. The latter only requires separate mention.

Hammer finger is a condition which resembles 'hammer toe' in the foot. The finger is flexed to a right angle at the first phalangeal joint, while the first phalanx is usually in a state of slight hyper-extension at the metacarpo-phalangeal joint. The cause of the condition is not known, but it usually occurs in young girls, and by some is said to be due to tension of the lateral ligaments. By using a little force, or by giving an anæsthetic, the flexion can be overcome, at all events, in the earlier stages; later on the skin and fascia over the palmar surface of the joint become contracted and the deformity permanent. It most usually affects the little finger. The treatment consists in placing the patient under an anæsthetic, straightening the finger and fixing it in this position with an anterior finger splint and strapping. If the finger cannot be straightened, the tense structures in front of the joint must be divided.

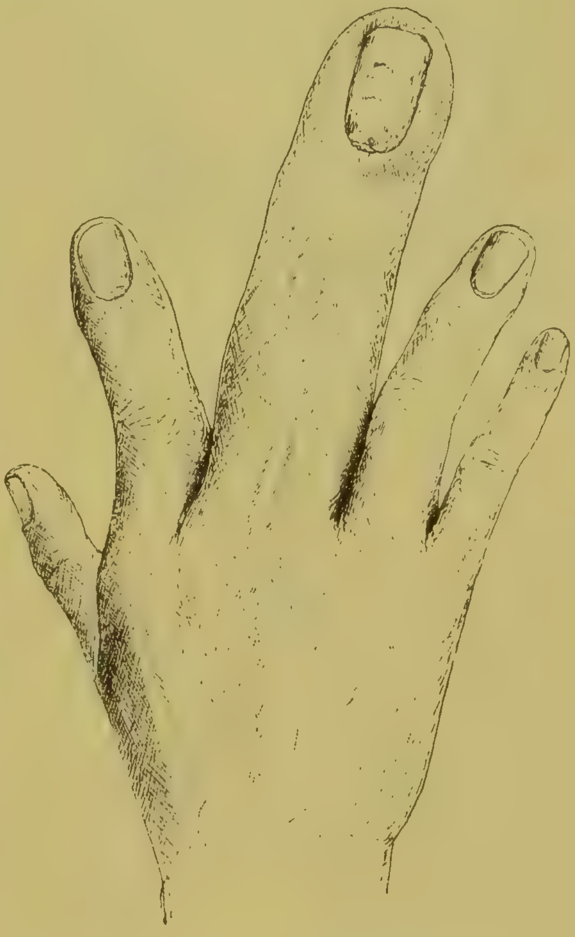

Fig. 413.—Giant finger.
(From the Museum of St. George's Hospital.)

Deformities of the lower extremity.—**Coxa vara** is a deformity of the hip, which has only recently attracted attention, especially in Germany. The deformity is produced by an alteration in the angle between the neck and the shaft of the thigh bone, which is sometimes reduced to a right angle or even in bad cases to an acute angle. The neck of the bone is also bent in a horizontal plane, usually convex forwards, but occasionally backwards. The head of the bone generally becomes distorted. It usually occurs in adolescents, and the alteration of shape is due to the effects of gravity on bones softened by disease. Late rickets and osteomalacia are believed to be the principal causes of the softening of the bones. Cases are also described as occurring in young children, and the alteration in the bones is then due to rickets.

Symptoms.—Without any known cause, the patient is noticed to assume a waddling gait. Pain in the hip and knee is often complained of, but there is no local swelling or tenderness. The spine is in a condition of lordosis. On examination, the top of the trochanter is found to be above the level of Nélaton's line. The limb is shortened and rotated outwards, and often slightly flexed. The movements of abduction and rotation are distinctly limited. The symptoms very much resemble those of congenital dislocation of the hip, from which, in some cases, it is impossible to diagnose it except by means of the Röntgen rays.

Treatment.—In the early stages of the disease rest and extension, with attention to hygienic and dietetic measures, may be tried; but where the disease is advanced and the deformity pronounced, osteotomy below the trochanters is the best plan of treatment.

Genu valgum (*knock-knee*) is a very common affection among the children of the poor in this country. It is practically an increase in the angle normally found between the axes of the femur and tibia, so that the inner side of the knee forms the apex of a triangle, the sides of which correspond to the femur and the tibia, and the base to a line drawn from the trochanter to the outer malleolus. It usually affects both extremities in the same subject, but is generally more pronounced on one side than the other (fig. 414)

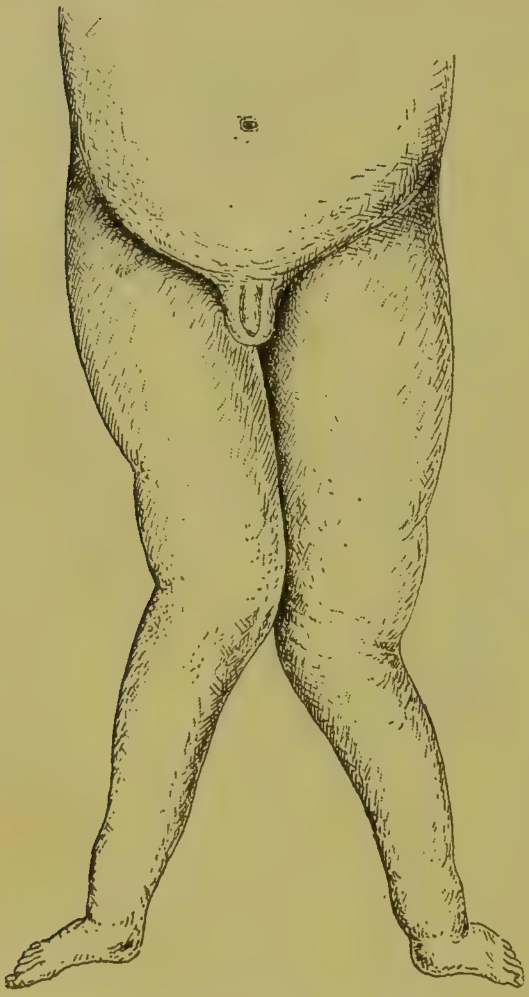

FIG. 414.—Genu valgum.

Etiology.—In considering the causes of this disease, we must divide it into two varieties: (1) The rachitic genu valgum of young children; and (2) the static genu valgum of adolescents.

1. The **rachitic genu valgum**, as its name implies, is due to rickets, and for the most part makes its appearance between the ages of two and four. It may be caused in two different ways: (*a*) by irregularity of growth at the epiphysial line; and (*b*) by bending of the shaft of the bone.

(*a*) Irregularity of growth at the epiphysial line is one of the commonest features of rachitic disease in bones, and in genu valgum consists in an unequal growth at the inner and outer parts of the growing tissue in the neighbourhood of the epiphysial cartilage, consisting of defective growth at the outer side and excessive growth at the inner, so that the line of the epiphysis becomes oblique in a direction downwards and inwards, and the two condyles are not on the same horizontal plane, the internal one being on a lower level than the outer, and consequently causing a similar alteration in the plane of the articular surface of the tibia and in the direction of the axis of this bone, which is displaced outwards. Superadded to this there is in many cases a similar condition of the tibia—that is to say, excessive growth at the inner side and deficient growth at the outer side of the epiphysial line, and a consequent curvature of the upper end of the tibia, with the result that the shaft of the bone is still further directed outwards. The cause of this inequality in the growth would appear to be unequal pressure. In the natural condition of parts, in consequence of the obliquity of the femur, the pressure of the outer condyle of the femur on the outer tuberosity of the tibia is greater than the pressure of the inner condyle on the inner tuberosity, and when the growing end of the bone is, in rickets, in its characteristic condition of abnormal excess of growing tissue, with imperfect ossification, the growth is defective where there is great pressure, excessive where there is slight pressure. It will easily be seen that, when once the deformity has begun, the cause will be increased, and the deformity proceed more and more rapidly until ossification takes place.

(*b*) Genu valgum may be produced by a bending of the shaft of the bone. All bones in rickets are soft and have a tendency to bend, but especially the bones of the lower extremity from the weight of the body. The femur is usually bent forwards and outwards in the direction of its greatest curve, but this is accompanied by a bending of the lower end of the bone, with its convexity inwards, probably partaking of the nature of a compensatory curve, and when this takes place the internal condyle is displaced downwards, the leg thrown outwards, and genu valgum produced.

2. **Static genu valgum of adolescents.**—This occurs much in the same way as lateral curvature of the spine and flat foot, with which this condition is often associated. It usually occurs about the age of puberty in weak individuals with deficient muscular power. When the muscles are weak and inefficient in bracing up the joint, the whole strain is thrown on the internal lateral ligament, for on account of the centre of gravity from the hip joint falling on the external condyle and external tuberosity of the tibia, or, at all events, outside the centre of the knee, there is a natural tendency for the knee to yield in an inward direction, and if there is flat foot this tendency is increased. In consequence of this, great strain is thrown on the internal lateral ligament, and it gradually yields. Then similar changes take place in the lower end of the femur, as in the rachitic form of the disease; the parts which have to bear the pressure grow slowly,

those which are relieved of the pressure grow quickly, and an apparent elongation of the internal condyle takes place from deficient growth on the outer side and increased growth on the inner side of the epiphysial line.

Symptoms.—The signs of knock-knee are sufficiently obvious. When the patient is a child, he is noticed to be unsteady in his gait, and to be constantly falling. When he is watched while walking or running, it will be noticed that the knees have a tendency to cross, and that occasionally he knocks them together, and this causes a fall. When laid flat on a couch and the knees made to touch each other, the two malleoli will be found to be widely separated, and the interval between them will be the measure of the deformity. There is a marked projection on the inner side of the knee of the inner condyle and the inner tuberosity of the tibia. The patella is usually displaced outwards. When the legs are flexed on the thighs the deformity disappears; the two malleoli will now be almost in contact, and the axes of the tibiæ parallel to each other. The projection of the internal condyle has also disappeared. This is due to the alteration in the relation of the articular surface of the tibia to the condyles of the femur, the tuberosities of the tibia being now in contact with the posterior surfaces of the condyles, instead of their inferior surfaces.

Treatment.—In young children, up to the age of five or six, when the deformity is not very great, cases of genu valgum may be cured without operation. This is especially true of the children of the wealthier classes, who are in a position to afford the necessary instruments, and will devote the requisite time and attention to the treatment. In these cases the general treatment for rickets must be adopted (page 213). Massage, and attempts by passive motion to straighten the bones, should be constantly employed, and day and night instruments should be worn to correct the deformity. The day instrument consists in a long outside steel support, which is fixed into a socket in the heel of the boot below and to a pelvic band above, with a hinge joint at the hip, knee, and ankle, and a metal band, straps, and buckles round the thigh and leg. A knee-cap is adjusted over the inner condyle, which is buckled with sufficient tightness *over* the steel support on the outer side of the knee (fig. 415). At night long splints firmly bandaged over the knee may be substituted for this.

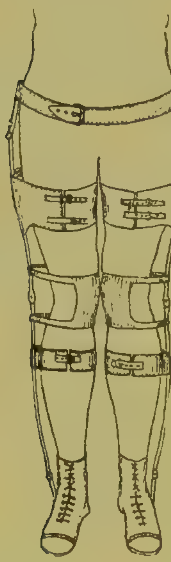

FIG. 415.—Mechanical appliance for the treatment of genu valgum.

When the patient is older, and the amount of deformity is greater, operative interference is necessary. The operations in ordinary use are of two kinds—osteotomy and osteoclasia. Osteotomy is the one usually employed, and consists either in a transverse section of the femur above the epiphysial line, known as *Macewen's operation*, or an oblique section into the knee joint separating the internal condyle (*Ogston's operation*).

Macewen's operation, or some modification of it, is now almost universally employed, as yielding better results than Ogston's. Macewen recommends that the section should be made with an osteotome—that is to say, with a chisel bevelled on both sides—and that the incision should be made from the inner side at a point a finger's breadth above the top of the external condyle, and half an inch in front of the adductor tubercle. Other surgeons prefer to divide the bone with a saw, and to attack the bone from the outer side. To facilitate the performance of this operation, Davy has invented a special grooved knife and saw, which is very convenient and which I always use. I introduce the knife on the outer side of the thigh, about a finger's breadth above the level of the adductor tubercle, and carry it straight down to and in front of the bone, until the cutting edge rests on the anterior surface of the shaft of the femur. The knife is held in this position with the left hand, while the saw is slipped down the groove in the knife, until its cutting edge also rests on the anterior surface of the femur. The sawing is then commenced, the knife being retained in position until a groove has been made in the bone; it is then withdrawn, and about two-thirds of the thickness of the bone sawn through; the solution of continuity is completed by forcibly breaking the remainder. The limb is then straightened, and the wound dressed, no suture as a rule being required, and at once put up in plaster of Paris. The wound requires no dressing for ten days, when the plaster is taken off, the dressings removed, and the limb is again put up in the plaster casing for three months.

Osteoclasia consists in forcibly breaking the bone either by the hands or by an osteoclast. By the former method the surgeon firmly grasps the thigh a little distance above the patella, using his thumb as a fulcrum, and then seizing the leg with the other hand, straightens the limb until the bone yields. By means of the osteoclast the bone is broken much in the same way by the special instrument which has been devised for this purpose. I have never employed these methods, which seem to me to be barbarous, and a confession on the part of the surgeon that he is afraid of his powers of keeping the wound aseptic; but many surgeons of repute speak highly of this method, and constantly employ it.

Genu varum (*bow-knee*) is the opposite condition to genu valgum. It usually occurs in those cases of rickets where there is a general curve of both femur and tibia in an outward direction. The condition is met with in heavy, rickety children, in whom the bones yield from being soft and unable to bear the weight of the child. The disease is not attended with the same alteration in shape of the femoral condyles, as in the rachitic form of genu valgum, and differs from the static form in the fact that it is the bones which first give and not the ligaments. The two conditions of genu valgum and genu varum may exist in the same individual, one knee being bowed outwards, the other inwards.

The **treatment** consists in the ordinary general treatment for rickets: in massage and manipulation to the limbs, and in the application of a light wooden splint on the inner side, to which the limb is bandaged, and which should project some inches below the level of the feet, so as to keep the child completely off its legs. If not cured in early life, osteotomy of the femur and tibia may be required later on.

Genu recurvatum is a rare and usually a congenital malformation, in which the legs are hyper-extended on the thighs, so as to form an angle with them. The congenital form is due to malposition in the uterus; the legs, instead of being flexed on the thighs, as in the normal position, being hyper-extended along the ventral surface of the body. In these cases the articular surface of the tibia lies in front of the condyles of the femur, and the patella above the intercondyloid notch. The crucial ligaments and posterior part of the capsule are tense and stretched, and there is often considerable rotation of the leg. In the adult, genu recurvatum is the result of paralysis of the popliteus and the flexor muscles of the leg, or of some nervous disorder, as ataxia. When the above-named muscles are paralysed, the femur falls forward on the tibia, and the line of gravity is carried in front of the knee joint; the posterior ligaments become stretched, and after a time yield, and over-extension of the leg takes place. Genu recurvatum may also occur as the result of rupture of the posterior ligament of the knee joint.

The **treatment** of the congenital form consists in attempting to overcome the deformity at the earliest possible period by manipulations and careful splinting. If this cannot be done, an attempt may be made when the child is two or three years old to overcome the resistance, which would appear to be the contracted capsule and ligaments, by division of these structures. In those cases of genu recurvatum which occur in adult life as the result of disease, no special treatment will probably be deemed advisable.

Bowed legs.—In speaking of rickets it has been mentioned that the tibia and fibula are frequently much bent and distorted. The distortion consists usually in a bowing forwards and outwards of the lower third of the bones, and is a most common condition among the children of the poor in this country. In young children the treatment consists in the application of well-padded wooden splints on either side of the limb. These splints should extend from the knee to well below the level of the foot, so as to keep the child entirely off its legs. This, combined with general treatment, will probably effect a cure. But if the deformity is at all excessive, I am usually in the habit of commencing treatment by placing the child under an anæsthetic and forcibly straightening the bones as far as possible. This can usually be done without fracturing them, as the bones are very soft; but even if they are broken no harm will have been done, and the limb can be put up in a straight position. Later in life, when the bones have become fixed in their distorted position, and all active symptoms of rickets have disappeared, a cuneiform osteotomy will have to be performed. The bone is exposed by an aseptic incision, the periosteum divided and turned back, and a wedge-shaped piece taken out of the most prominent part of the tibia, the apex of the wedge corresponding to the concave surface of the bone. The size of the wedge must depend upon the amount of deformity. The fibula must then be divided and the limb straightened. The periosteum is replaced over the line of section, and may be secured in position by a catgut suture; the wound is closed and dressed, and put up in a pair of Croft's plaster of Paris splints.

Talipes or **club foot.**—By the term *talipes* or club foot is meant any deformity of the foot caused by an unnatural contraction of muscles, ligaments, or fasciæ, whereby the normal relations of the tarsal bones to each other and to the bones of the leg are altered. Four primary varieties of this deformity are described: (1) *Talipes equinus*, where the heel is raised and cannot be brought to the ground, and where, in the extreme condition, the patient walks on the distal ends of his metatarsal bones; (2) *talipes calcaneus*, in which the toes are raised, so that the patient walks on the point of the heel; (3) *talipes varus*, where the inner side of the foot is raised and the anterior part turned inwards, so that the patient walks on the outer border of the posterior half of the foot; (4) *talipes valgus*, in which the outer edge of the foot is drawn upwards and everted, and the patient walks on the inner border of the foot and the inner ankle. Not infrequently two of these primary varieties may be found in combination. Thus we may have *equino-varus* or *valgus*, or *calcaneo-varus* or *valgus*.

Etiology.—The causes of talipes are very numerous, and may be classed under two heads, as to whether the club foot is congenital or acquired.

The **congenital** form has been attributed to several causes. The most common one is deficiency in the amount of the liquor amnii, so that the feet are abnormally compressed by the wall of the uterus. The greater number of cases of congenital club foot are equino-varus, and it will readily be understood that in consequence of the position which the child occupies in the uterus, with the lower extremities closely flexed against the abdomen and thorax, if there is a deficiency of liquor amnii, the feet would be maintained in a position of equino-varus during the development of the child, and the ligaments and muscles on the one side would be stretched, while those on the other would be contracted, and a permanent condition set up. This accounts for the fact that this form of talipes is usually bilateral. But it is also clear that this is not the sole cause, but that congenital club foot is also due in some cases to disordered nerve function acting on the muscles which draw the foot into its deformed position. Its frequent association with spina bifida would seem to indicate this. It is possible also that congenital club foot may in some instances be due to imperfect development of the bones of the leg or foot.

Acquired talipes is due to various causes. The most common of these is infantile paralysis, where a single group of muscles is paralysed, the bones being drawn into their abnormal position by the unbalanced action of the muscles antagonistic to those paralysed. In the same way division of a nerve by accident or during an operation may produce a similar result. Division of the internal popliteal nerve paralysing the flexor muscles causes calcaneo-valgus, and division of the external popliteal nerve paralyses the extensors and peronei, producing equino-varus. Among less common causes of acquired club foot are spasmodic contraction of muscles from spinal mischief; or cicatricial contraction of muscles after abscess or rupture; or cicatricial contraction of the skin and subcutaneous tissues from burns and other lesions; or, finally, the prolonged maintenance of the foot in a faulty position, as in cases where the patient has been long confined to bed, and the pressure of the bed-clothes has kept the foot in an extended position. This is known as *talipes decubitus*.

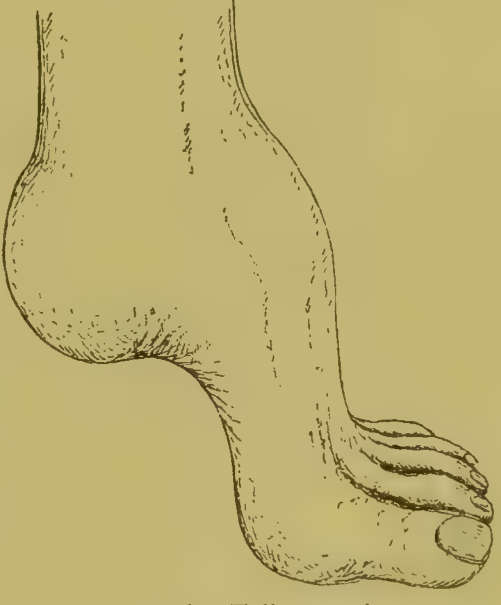
FIG. 416.—Talipes equinus.

Talipes equinus (fig. 416), where the heel is drawn upwards, so that the patient walks cn the metatarso-phalangeal joints and the toes, is very rare as a congenital condition, and usually arises from infantile paralysis affecting the extensor muscles, or else from injury to the anterior tibial nerve, producing paralysis of these same muscles, the unbalanced action of the calf muscles raising the heel. When the disease arises from infantile paralysis, the elevation of the heel may not be very great, and the patient walks on the balls of his toes, with a limp. But in the severer forms the calcaneum is drawn into an almost vertical position ; the tarsus is curved forwards, so as to approximate the metatarso-phalangeal joints to the heel, and the muscles and fasciæ in the sole of the foot are much contracted (fig. 417). Under these circumstances the patient walks on the heads of the metatarsal bones, with the toes hyper-extended. The changes in the shape of the bones of the tarsus are not very great in this variety, but there is a partial displacement of the astragalus in the tibio-fibular mortise, only the posterior part of its articular surface resting against the lower end of the tibia.

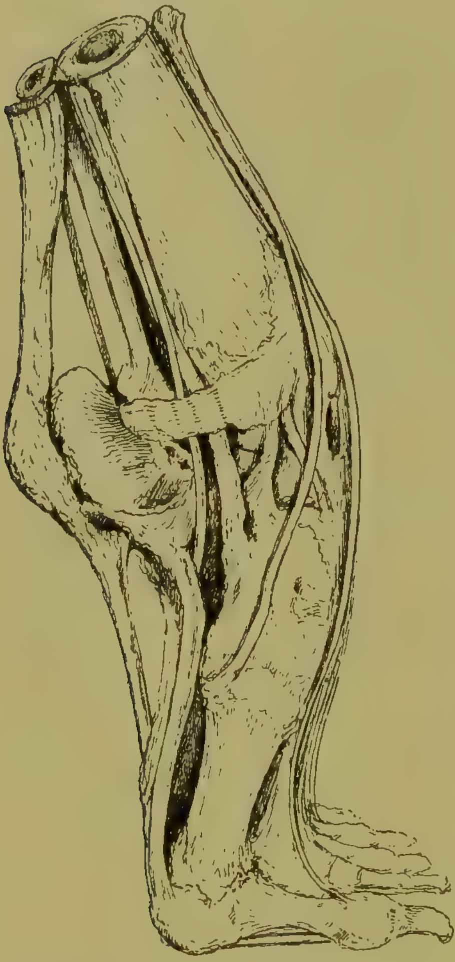

FIG. 417.—Dissection of an old case of talipes equinus. (From the Museum of St. George's Hospital.)

Treatment consists in elongating the contracted muscles. In slight cases this may sometimes be done by constantly repeated manipulations, and by applying elastic extension in such a way as to cause traction on the contracted muscles. This may be effected by attaching to the front of the sole of the boot an elastic cord, which is connected above to the front of a metal collar fixed round the leg just below the knee, and always kept in a condition of tension. Generally, however, division of the tendo Achillis will be found to be the simplest and easiest way of treating this deformity. The tendon is divided subcutaneously by turning the patient into the prone position, and introducing the tenotome by the side of the tendon a short distance above the level of the os calcis, where the tendon is thinnest, and pushing it under and as close as possible to the tendon. When this has been done the cutting edge of the tenotome is turned towards the tendon, and by a sawing movement it is cut through, an assistant holding the foot in as flexed a position as possible, in order to tighten the tendon. As soon as it is divided, it will give way with an audible snap, and care must be observed that the knife does not slip and transfix the skin over the tendon. The wound is at once closed with gauze and collodion, and the foot having been brought into its normal position, is put up in plaster of Paris. The foot must be kept in the plaster for three months, until the union is thoroughly consolidated, and the patient should then wear steel supports, with a lock in the joint at the ankle, so that the foot cannot be extended beyond a right angle. This should be worn for twelve months. In very severe cases of old neglected talipes equinus this is not sufficient. If the tendon is simply divided, and the foot brought at once into its normal position, the severed halves of the tendon are so widely separated that the subsequent union is not firm. In these cases the tendon should be spliced. This is done by exposing some inches of the tendon by a vertical incision, made with strict antiseptic precautions. The tendon is then split down its centre for three or four inches, according to the amount of deformity which exists; one half of the tendon is now divided above and the other half below; the foot is put in its normal position at right angles to the leg, and the two halves of the tendon where they overlap are sutured together (fig. 418). The external wound is then closed, and dressed, and put up in plaster of Paris.

Talipes varus as a pure condition is probably never met with, for it is almost always, if not always, associated with a certain amount of equinus, constituting the commonest of all the varieties of congenital club foot—*equino-varus*.

Talipes equino-varus (fig. 419) as a congenital affection most commonly arises from deficiency of the liquor amnii and undue pressure of the uterine wall; but it may also be acquired as a result of infantile paralysis of the extensor and peroneal muscles, those muscles which are supplied by the external popliteal nerve; or it may be the result of some spastic contraction of the muscles supplied by the internal popliteal nerve.

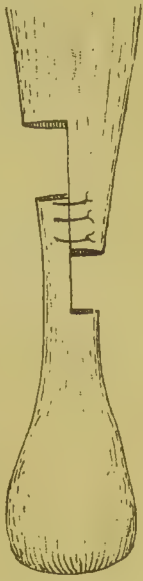

FIG. 418.—Diagram showing the method of splicing the tendo Achillis.

In these cases the heel is drawn upwards and the foot adducted, its anterior half being drawn inwards, so that the foot is, as it were, bent on itself at the mid-tarsal joint, the inner border presenting a deep sulcus or groove, corresponding to this articulation, and the outer border a prominent convex surface. When the child stands he rests on the outer border and partly on the dorsum, and a large bursa is usually developed in this situation. Where the deformity is of old standing, the bones become considerably altered in shape. The superior articular surface of the astragalus is displaced forwards from the tibio-fibular arch, and pushed towards the outer side of the dorsum. The neck of the same bone is elongated, and forms an angle with the body, so that the head is directed inwards and the navicular is displaced to its inner side, and is almost in contact with the internal malleolus; the cuboid is turned downwards so that its dorsal surface rests on the ground, and the metatarsal bones form a more or less vertical, instead of a horizontal, series. The muscles which are shortened are the tibialis posticus, anticus, and the muscles forming the tendo Achillis. As age advances, the maintenance of the deformity is not due alone to these shortened muscles; they may all be divided and still the deformity cannot be remedied, for the ligaments on the inner side of the foot, being relaxed, also become shortened, and later on the alteration in the shape of the bones interferes with restoring the foot to its normal position. In consequence of the contraction of the long and short plantar ligaments and the plantar fascia, which also becomes contracted, the arch of the foot is often much exaggerated, and the ball of the toes approximated to the heel. These facts have an important bearing on the treatment of the case.

Treatment.—It cannot be too strongly insisted upon that in a case of congenital club foot treatment should be commenced from birth. If this were done, in many cases the subsequent contraction of the tendons and ligaments, and later on the alteration in the shape of the bones, necessitating often severe operations, would be avoided. If an infant, the subject of congenital talipes equino-varus, is examined within a day or two after birth, it will be found in most cases that the deformity can be corrected with the slightest possible amount of force, and without causing the child any pain; but if two or three months are allowed to elapse before the examination is made, it will be found that the rectification of the deformity is much more difficult, is attended with pain, and that the tibial tendons and the tendo Achillis become tense, and stand out prominently when the attempt is made. With an intelligent nurse, who will loyally carry out the instructions given her, considerable progress towards a cure may be made in the first month or six weeks of life. She should be told that at every available opportunity she should carefully manipulate and mould the foot into its proper position. Whenever the child is lying on her lap her hand should be on the foot, carefully stretching and moulding it, and this may be done without the slightest pain to the infant. At night a small metal splint should be bandaged to the outer side of the limb with a soft flannel bandage, with the foot in as normal a position as it can be placed. By this simple means many cases can be

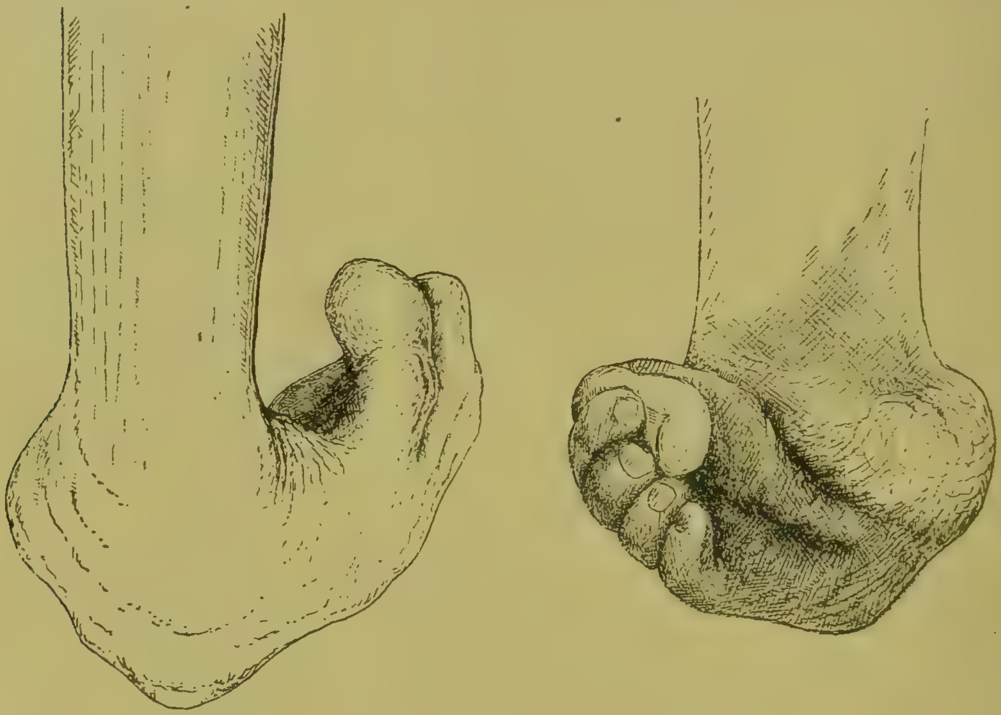

FIG. 419.—Talipes equino-varus.

cured, if only the treatment is begun at once. If, however, the child has arrived at the age of two or three months before it is brought under the surgeon's observation, or if these means do not suffice, some operative measure will usually be required. This in young children up to the age of three or four consists in division of the tendons of the shortened muscles, the tendo Achillis, and the two tibial tendons. This will usually suffice at this age to effect a cure. I am strongly of opinion that in these cases the two tibial tendons should first be divided and the foot unfolded, before the tendo Achillis is interfered with. If this is not done there is no fixed point from which to unfold the foot and overcome the varus, and the attempt to do so is only followed by a further extension of the tendo Achillis.

Operations for cure of equino-varus. **Tenotomy.**—The tibial tendons are divided as follows: First, the posterior tibial tendon is cut by placing the child's leg on its outer side and introducing a sharp tenotome just behind the posterior border of the tibia, about an inch and a half above the malleolus. The knife should pass between the tendon and the bone, and the evidence to the surgeon that it has done so will be in the fact that the knife will be felt to be gripped between the tendon and the bone when the foot is everted. When the surgeon has satisfied himself that this is the case, he withdraws his sharp tenotome and replaces it by a blunt-pointed one, and then turning its cutting edge towards the tendon, by a gentle sawing movement, at the same time that the assistant everts the foot, he divides the tendon, the division being evidenced by a sudden yielding and an audible snap. The wound is at once sealed with a pad of gauze and collodion, the child turned on to its back, and division of the anterior tibial proceeded with. The surgeon stands at the end of the table facing the child, and, seizing the anterior part of the foot in his left hand, by extending and everting it defines the anterior tibial tendon; he introduces his tenotome close to the tendon, pushes it beneath it, and then, by cutting outwards, keeping the foot in the extended and everted position, he divides it. As soon as the yielding of the tendon shows him that it is divided, he withdraws the knife, seals the wound with a gauze pad and collodion, and at once proceeds to correct the varus, bringing the foot into a straight position, so that the inner tuberosity of the tibia, the internal malleolus, and the ball of the great toe are in the same straight line, and puts it up in this position in plaster of Paris. At the end of six weeks he proceeds to deal with the equinus by dividing the tendo Achillis in the manner above described.

If the child has attained the age of three or four, and has been neglected, probably division of the tendons alone will not suffice. It will then be necessary to perform the operation which Mr. Parker has termed *syndesmotomy*, or else the one which goes by the name of *Phelp's operation*, for by this time the ligaments will probably be also contracted.

Parker's operation consists in dividing the ligaments about the astragalo-navicular joint, as well as the two tibial tendons, by one incision. A narrow straight tenotome is introduced a little below and in front of the tip of the internal malleolus, and is carried inwards under the skin on to the dorsum, just to the outer side of the anterior tibial tendon, which must previously have been defined. The knife is then withdrawn and a sickle-shaped knife inserted flat-wise along the track thus formed; it is then turned with its cutting edge downwards, and made to divide all the structures down to the bones. The anterior tibial tendon, the ligaments, and the posterior tibial tendon will be felt to yield, and it will be found that the position of varus can be entirely corrected. The subsequent treatment is the same as after division of the tendons alone.

Phelp's operation consists in making a vertical incision across the inner border of the foot over the astragalo-navicular joint. The position of this joint is always indicated by the crease of the skin spoken of above as being present in cases of equino-varus. The incision is to be carried down to the joint, dividing the inferior calcaneo-navicular ligament, and freely opening the articulation. The anterior part of the internal lateral ligament of the ankle, the two tibial tendons, and the inner part of the plantar fascia are also divided, and the tendo Achillis is divided subcutaneously. It will now be found that the foot can be placed in a slightly everted position, leaving a large gaping wound, which is to be carefully packed with antiseptic gauze, and the foot done up in a plaster of Paris splint. The wound should be dressed at the end of a week or ten days and the gauze removed. The subsequent granulation may be hastened by skin-grafting. Some surgeons think very highly of this operation and advocate its performance in very severe cases of old-standing, neglected talipes. I have seen some very good results when performed in earlier cases, before deformity in the bones has taken place, but I should advise its restriction to this class of case. It is always open to the objection that contraction of the large scar is liable to take place, with a recurrence of the deformity.

In very bad inveterate cases of talipes equino-varus in children over the age of seven or eight, when the bones are deformed and altered in shape, severer measures than those above described are necessary. And for these cases one of two operations may be performed—either excision of the astragalus or tarsectomy.

Excision of the astragalus is often a most satisfactory operation in these cases, and I have had some most admirable results following its performance. It is done in the manner described on page 579, and after the removal of the bone the foot can be got into good position, and the amount of subsequent deformity which is left is very slight.

Tarsectomy, or removal of a wedge-shaped piece of bone from the outer side of the tarsus, is also followed by very good results in many cases. The operation is performed by making a T-shaped incision on the outer side of the foot, after surgical cleansing of the limb. Some surgeons prefer to perform the operation by the 'bloodless' method, by applying Esmarch's bandage; my own feeling is against this, on account of the troublesome oozing which sometimes takes place after its use. The horizontal limb of the T-shaped incision is carried along the outer border of the foot over the calcaneum and cuboid bones; the vertical limb is carried across the dorsum of the foot as far inwards as the scaphoid, about midway between the external malleolus and the tuberosity of the fifth metatarsal bone. The flaps of skin thus formed are turned up. If the skin over the convexity of the outer border of the foot is indurated and callous, a portion of it may be removed. The tendons and vessels are then separated from the dorsal surface of the tarsus with a periosteum elevator and held out of the way with retractors. A narrow-bladed saw is now applied at the posterior extremity of the incision and an oblique cut made forwards through the os calcis and carried as far inwards as the scaphoid. The saw is then introduced at the anterior extremity of the wound and an oblique cut made backwards through the cuboid to meet the first one. A wedge-shaped piece of the tarsus, consisting of part of the os calcis and part of the cuboid, has now been separated. This is to be seized with lion-forceps, and with slight touches of the knife separated from the soft parts in the sole of the foot and removed. The two cut surfaces of bone are to be brought into apposition. If sufficient bone has not been removed to allow of the foot coming straight, more must be removed with the chisel from the cuboid. When the foot can be got into its normal position, any tendons which have been accidentally divided must be joined again with catgut suture, and the flaps of skin brought together with interrupted sutures, the wound dressed with gauze and put up in a plaster of Paris casing.

As regards the choice between the two operations, I prefer the excision of the astragalus in cases where this bone is very prominent and deformed. Tarsectomy leaves the foot much shortened and flattened, and in many cases rigid and stiff, whereas the deformity after excision of the astragalus is very slight. But in some cases it will be found that after excision the position of the foot cannot be quite rectified. Under these circumstances the surgeon may succeed in getting the foot into good position by dividing the external malleolus.

Talipes calcaneus (fig. 420).—This is a very rare form of club foot, which may be either congenital and associated with spina bifida or acquired. When acquired, it is generally due to infantile paralysis of the muscles of the calf, giving rise to unbalanced action of the extensor muscles. In a minor degree it may also arise after division of the tendo Achillis, from stretching of the bond of union, when care has not been taken to prevent undue tension on the tendon before the union is firm. In this form of talipes the toes are drawn upwards, and the patient walks on his heel, over which thickened skin and subcutaneous tissue, and sometimes a bursa, form, giving an appearance of undue elongation of the heel. The structures in the sole of the foot become contracted and produce an exaggeration of the normal arch, and on the dorsum of the foot the extensor tendons can be felt tense and tightly stretched. The toes are usually flexed, on account of the long flexor tendon being stretched as it passes round the internal malleolus. In the congenital form talipes calcaneus is usually associated with a certain amount of valgus, constituting the condition known as *calcaneo-valgus*. In these cases the foot merely retains the position which it assumes during the later period of intra-uterine life, and, as a rule, at

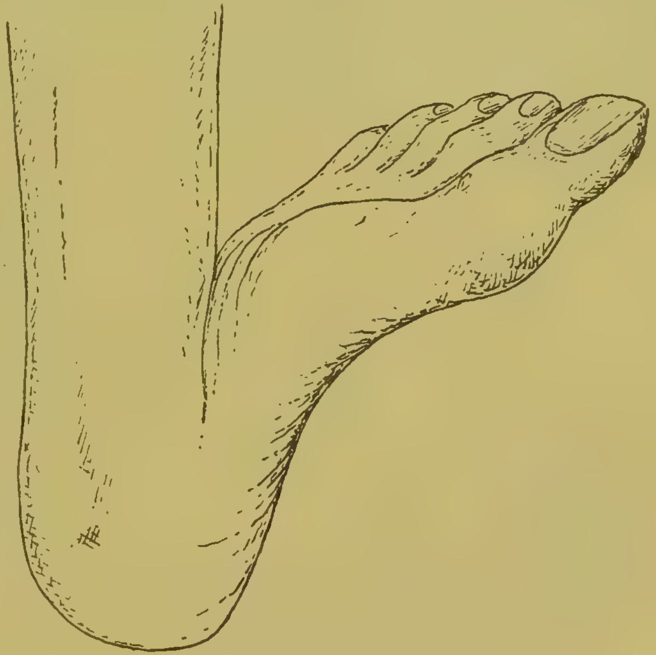

FIG. 420.—Talipes calcaneus.

birth the position of the foot can be rectified without any difficulty. If, however, the condition is allowed to remain untreated, the tissues contract, and the foot becomes fixed in this abnormal position.

Treatment.—The deformity of talipes calcaneus can usually be corrected by careful manipulation and passive movements, combined with some simple retentive apparatus. It is only in exceptional cases that any operation is required; but in some old and rigid cases it may be found necessary to divide the extensor and peronei tendons, as well as any ligaments which may be felt to be tense and which prevent the foot being brought into its proper position.

Recently a new method has been proposed for treating deformities of the limbs resulting from infantile paralysis, and as this plan of treatment has given the best results in talipes calcaneus, this is perhaps the best place to allude to it. It consists in reinforcing the paralysed muscle by attaching to its tendon the tendon of a healthy muscle, and the proceeding is known as *tendon grafting*. In cases of talipes calcaneus the peroneus longus and brevis are grafted to the tendo Achillis, but the operation may be utilised in many other deformities. Thus in cases of varus from paralysis of the peronei, the condition may be remedied by taking a strip from the tendo Achillis, and attaching it to the peroneus longus; and in talipes valgus, due to paralysis of the tibialis anticus and posticus, a portion of the extensor proprius hallucis may be grafted into the tibialis anticus, and a portion of the flexor longus digitorum into the tibialis posticus. The operation must be done with strict antiseptic precautions, since its success depends upon union by first intention. The tendons are exposed and their sheaths opened, and the tendon of the paralysed muscle divided, and its proximal end attached by suture to a portion of the tendon of the muscle with which it is intended to connect it; this having been previously split off from the rest of the tendon.

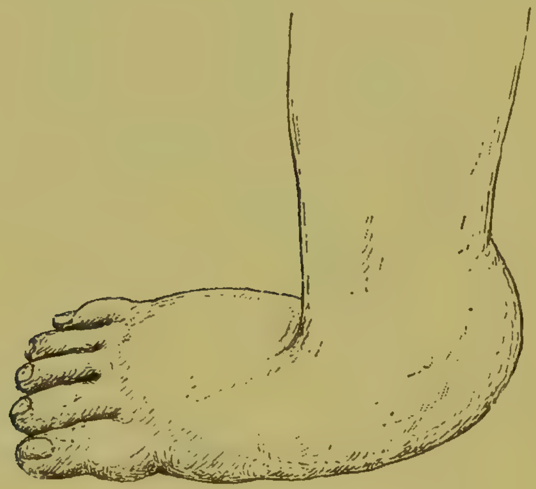
FIG. 421.—Talipes valgus.

Talipes valgus (fig. 421) is rarely met with as a congenital condition, except in association with calcaneus, but is not infrequently met with as an acquired condition, either from spastic contraction of the peronei muscles or paralysis of the tibial muscles. It then closely resembles flat foot. The foot is abducted and everted, and the patient walks on its inner border, the arch of the foot having disappeared. The navicular bone is partially displaced outwards from the head of the astragalus, so that this process of bone appears under the skin on the inner side of the foot as a rounded prominence.

The **treatment** consists in placing the patient under an anæsthetic and forcibly wrenching the foot into position, with or without division of the peronei tendons. The foot is then put up in a plaster of Paris splint for a time, and subsequently moulded and manipulated until the natural condition of the foot is restored. The patient should wear boots without high heels, and should have 'valgus pads' inserted into them. The success in the treatment of these cases depends upon perseverance with the manipulations after the wrenching has been performed.

Flat foot or **splay foot** (fig. 422) is one of the commonest deformities of the lower limb. It is caused by a weakness of the muscles in the sole, and relaxation of the ligaments, so that the arch becomes lost and the foot flattened. The arch of the foot is maintained principally by the inferior calcaneo-navicular or 'spring' ligament, which is a highly elastic structure and which is supported and prevented from being overstretched by the expansion of the tendon of the tibialis posticus muscle, which spreads out like a fan to be inserted into most of the tarsal and some of the metatarsal bones, and by the short muscles in the sole of the foot. When these muscles are weak, they allow the ligament to become overstrained, and it loses its elasticity and becomes relaxed, and the arch of the foot becomes gradually lost. The exciting cause is overstanding, especially in growing boys or girls, or in young adults. The disease is, therefore, very common in nurses, shop-people, and others who are compelled to stand for many hours every day. When the arch becomes lost, there is a tendency for the foot to become everted. The navicular bone is displaced outwards from the head of the astragalus, which forms a rounded prominence on the inner side of the foot. The transverse ligament binding the heads of the metatarsal bones together also becomes stretched and the lateral arching upwards of the foot disappears. Great pain is often complained of after standing or walking, and the gait is shuffling and ungainly.

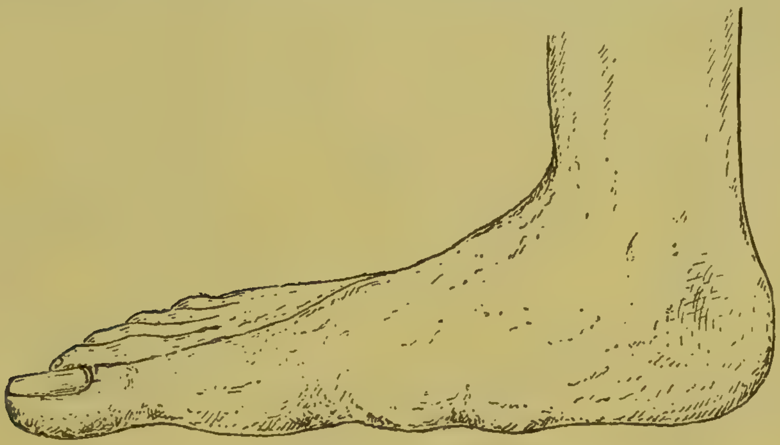

FIG. 422.—Flat foot, or spurious valgus.

Treatment.—The treatment of flat foot consists, in the first instance, in improving the general health and muscular tone of the patient by fresh air, regulated diet, tonics, and other means; secondly, in removing the cause which led to the condition—overstrain or fatigue to the foot by prolonged standing, too much walking, carrying heavy weights, and so on. Without this all local treatment to the foot will be of no avail. When the disease is in its initial stage, the treatment consists in massage to the foot and leg muscles, and regulated exercises to improve their tone. The exercises should be devised with a view to increasing the power of the muscles of the sole of the foot and the tibialis posticus. The patient should be instructed constantly to raise himself on his toes with the foot turned in, to walk on his toes and to hop, and these exercises should be repeated several times a day—not for too long a time at first, but gradually increasing the time as the muscles become stronger. The boots should be carefully fitted to the foot, wide and square at the toes, with the heels very little higher than the sole, and carried forwards as a triangular piece under the waist of the boot on the inner side, so as to support the inner border of the foot. In addition to this they should be fitted with a 'valgus pad'—that is to say, a sole plate with a wedge-shaped piece of cork fixed to it to support the arch of the foot. In more advanced cases before these measures are adopted adhesions should be broken down and the position of the foot rectified by placing the patient under an anæsthetic and the anterior part of the foot forcibly wrenched inwards. In doing this, probably adhesions will be felt and heard to give way. After the foot has been brought into as normal a position as possible, it should be encased in plaster of Paris for a few weeks, and then the above mentioned treatment commenced. In very inveterate cases various cutting operations have been performed, such as excision of the head of the astragalus; osteotomy of the tibia and fibula above the malleoli; and removal of a wedge-shaped piece of bone including the head of the astragalus and the posterior articular surface of the navicular bone from the inner side of the foot. These operations are, however, rarely called for, and should not be done unless the patient is absolutely crippled.

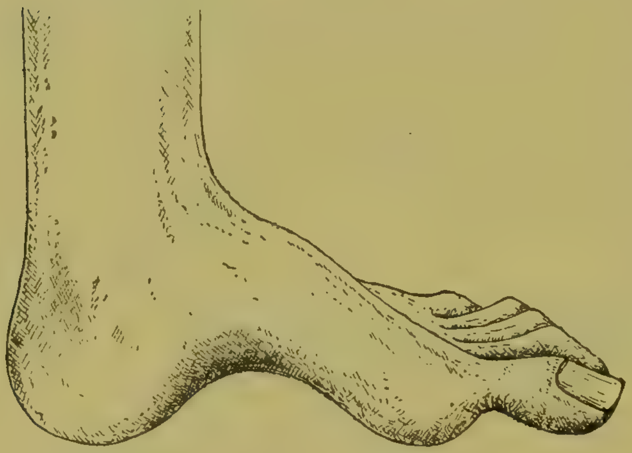
FIG. 423.—Pes cavus.

Pes cavus or **claw foot** (fig. 423) is a condition characterised by an exaggerated arching of the foot, with a peculiar position of the toes, the heel being at the same time raised and the foot inverted. In this condition the foot is shortened and the measurement from the toes to the heel diminished; the arch is raised, so that there is a well-marked hollow under the middle of the foot. The toes are in a condition of 'hammer toe'—that is to say, the first phalanges are hyper-extended, often to such an extent that their articular surfaces rest on the dorsal aspect of the heads of the metatarsal bones, which project prominently in the sole, and the second phalanx is acutely flexed on the first. There is still some difference of opinion as to the mode of causation of this condition. Duchenne believed that it was due to paralysis of the interossei and the short flexor and adductor of the great toe, which first produces the deformity of the toes from the unbalanced action of the muscles which extend the first phalanx and flex the other two, and then, by the continued action of the flexor longus digitorum and flexor longus hallucis, flex the mid-tarsal joint and cause the arching of the foot. The plantar fascia subsequently contracting renders the arching permanent. Parkin, on the other hand, believes that the initial condition is one of equinus, and that this is the cause of the cavus. For equinus to produce cavus it must not be extreme—that is to say, the long axis of the foot must be at an obtuse angle to the leg. When this is so, the weight of the body is transmitted to the toes obliquely, and there is a tendency to curl up the foot and by an overarching to bring the heel to the ground. This overarching, constantly repeated, becomes gradually permanent, and so claw foot is set up. The position of the toes is due, in Parkin's opinion, to the interossei becoming displaced from the first phalanges being hyper-extended on account of the equinus, and from the contraction of the extensor muscles. This deformity is easily recognised. It is accompanied by a good deal of pain after prolonged walking or standing, from the pressure of the weight of the body having to be borne upon the heel and the skin covering the prominent heads of the metatarsal bones.

The **treatment** of this condition is not very satisfactory, and if structural alterations have taken place in the tarsal arch little can be done to cure the deformity. Before this has taken place, the tendo Achillis and the plantar fascia should be subcutaneously divided, and about three weeks afterwards methodical manipulations should be regularly performed so as to unfold the foot. If these are persevered in for a considerable time, very great improvement may be obtained.

Hallux flexus.—In this condition the first phalanx of the great toe is flexed on the metatarsal bone, and is fixed in this condition so that it cannot be extended; there is no flexion of the terminal phalanx on the first, so that when the patient stands the end of the great toe rests on the ground and causes pain and seriously cripples the patient, as he is obliged to bear the weight of his body on the outer side of his foot. Davies-Colley, who first described the condition, attributes it, in most cases, to short boots. A somewhat similar condition, to a slighter extent, and where some amount of extension is possible, is sometimes met with in cases of flat foot. It is then termed *hallux rigidus.*

The **treatment** consists in the slighter cases in manipulation with a view to overcoming the inextensibility. In more severe cases the best mode of treatment is to excise the articular surface of the head of the metatarsal bone.

Hallux valgus (fig. 424) is a displacement outwards of the great toe, from partial dislocation of the metatarso-phalangeal joint, owing in the first instance to wearing boots with pointed toes, and secondly to osteo-arthritic changes taking place in the joint. In these cases the great toe is forced over or under the adjacent toes, and the phalanges form an angle with the metatarsal bone, the head of the latter bone forming a prominence on the inner side of the foot, which is constantly irritated by the friction of the boot. This sets up inflammatory changes, which result in alteration in the shape of the head of the bone and disorganisation of the joint. The skin over the prominence becomes thickened, and the bursa between it and the bone becomes enlarged.

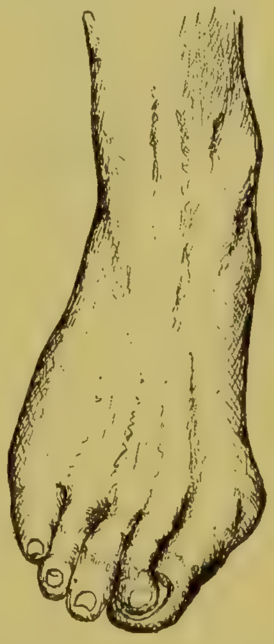
FIG. 424.—Hallux valgus.

This constitutes a *bunion*, which may ultimately suppurate, and the abscess open into the joint and lead to its destruction.

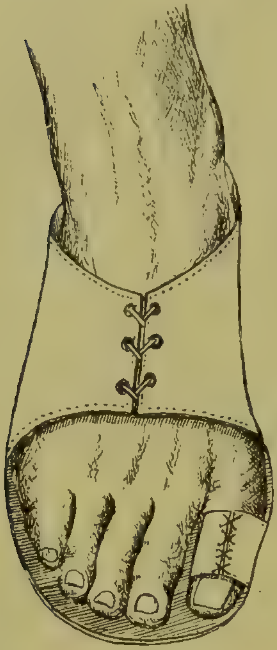

FIG. 425.—Sole plate for the treatment of hallux valgus.

Treatment.—In the early stages hallux valgus may be remedied by providing the patient with properly shaped boots, with the sole cut straight along its inner border. When changes have taken place in the shape of the bones, this is not sufficient, and an attempt should be made, by directing the patient to wear a sole plate, to remedy this condition. The sole plate (fig. 425) consists of a thin plate of steel accurately moulded to the under surface of the foot; in this slots are cut, and the toes can then be held in position by small straps passed through the slots and buckled over the toes. Failing this, a wedge-shaped piece of bone must be removed from the inner side of the distal end of the metatarsal bone. The toe can then be brought into proper position, and must be retained there until union has taken place. When the bunion is inflamed and threatens to suppurate, it must be treated by rest and warm fomentations; and if the suppuration extends into the joint, amputation or excision may be called for.

Hammer toe (fig. 426).—This is a by no means uncommon condition, and most frequently attacks the second toe. The first phalanx is hyper-extended on the head of the metatarsal bone; the second phalanx is acutely flexed on the first; the position of the third phalanx is variable, sometimes flexed, sometimes extended. The first inter-phalangeal joint, therefore, projects above the level of the other toes, and, rubbing against the upper leather of the boot, causes acute pain. The skin over it becomes thickened and callous, and very often a bursa becomes developed beneath the thickened skin. When the patient stands, the end of the toe rests on the ground, and here also the skin becomes thickened and hypertrophied.

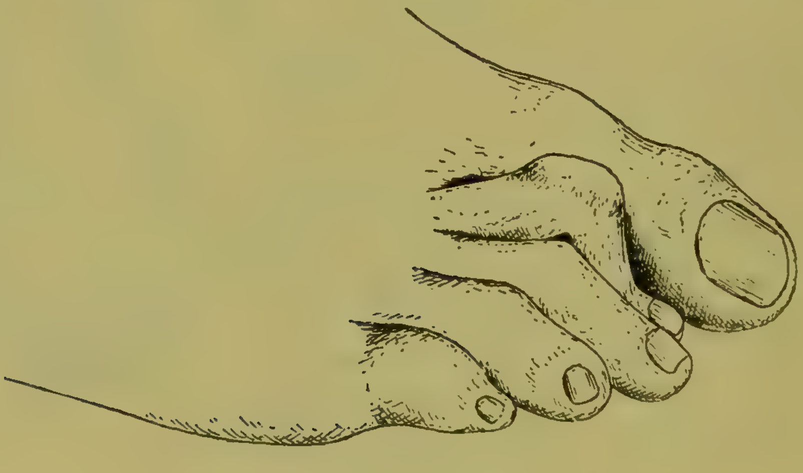

FIG. 426.—Hammer toe.

The causes of this affection are obscure. It is very often hereditary, and usually commences in early life; occasionally it is congenital. It has been attributed to wearing pointed boots, so that the toes are all crushed together, and also to wearing boots with high heels; though these may be the causes in some cases, they certainly are not so in all.

The **treatment** consists in excising the joint between the first and second phalanges. This can easily be done by a lateral incision on one side of the articulation. The joint is opened, the ligaments divided, and the ends of the bone turned out one after the other and cut off with a pair of cutting bone forceps. The wound is then closed and dressed, and the foot placed on a splint. This little operation gives most admirable results. Other plans of treatment which have been advocated are division of the lateral ligaments and amputation of the toe. They should not, however, be resorted to; the former because it is unsatisfactory, and usually leaves the patient in as bad a condition as he was in before; the latter, because, though it cures the condition, it is very likely to be followed by hallux valgus.

APPENDIX

AMPUTATION

By the word **amputation** is meant the removal of a part of the body, and in its widest sense is applied to the removal of certain organs, as the breast, testicle, or penis ; but in its more restricted sense it is commonly applied to the removal of a portion or the whole of a limb, and it is only in this restricted sense that it will be used in this place.

In performing an amputation, the main points which a surgeon has in view are : (1) the removal of the whole of the diseased tissues or those injured beyond the hope of recovery, and to do this with as little sacrifice of parts as possible ; and (2) to cut flaps of proper shape and long enough to cover the end of the bone or bones without tension. There are three main ways in which this latter object may be attained : 1. by the circular method ; 2. by the flap operation ; and 3. by the oval or racquet-shaped incision. These principal modes are variously modified to suit different conditions, as will be explained in the sequel.

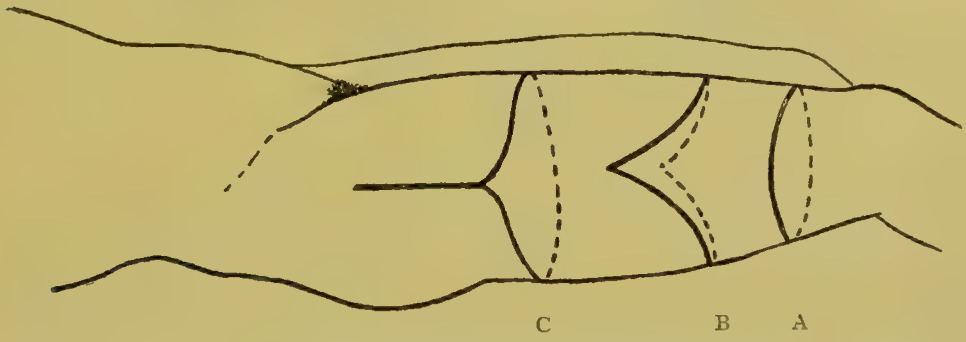

FIG. 427.—Diagram showing the line of incision in (A) circular, (B) flap, and (C) oval amputation.

1. The **circular method** (fig. 427, A).—The flaps in the circular method are fashioned by making a cut round the skin of the limb, some inches below the point at which it is intended to sever the bone ; then dissecting up the skin and subcutaneous tissue from the deep fascia, and throwing them back, like the cuff of a sleeve (fig. 428), about two-thirds of the distance towards the point of intended section of the bone. The superficial muscles are then divided by a second circular sweep of the knife at this level. The muscles retract, when divided, by virtue of their contractility, allowing the deeper muscles to be severed down to the bone at a higher level by a final circular sweep of the knife. Lastly, all the soft parts are pushed upwards from the exposed bone, and this is

sawn through at a slightly higher level than that at which the section of the deeper layer of muscles was made. In this way the limb is removed, and the stump consists of a cone-shaped hollow, of which the cut end of the bone forms the apex; the deeper layer of muscles projecting a little beyond it, the superficial layer of muscles projecting still further, and the whole being surrounded by a sleeve of skin and subcutaneous tissue, which projects still further beyond the severed muscles. The vessels are then ligatured, and the skin flaps brought together with sutures. This operation is not often performed. It possesses the disadvantage that the cicatrix is over the end of the bone, and owing to the shrinking of the soft parts the stump is apt to become conical and the cicatrix to become adherent to the end of the bone.

2. The **flap operation** (fig. 427, B) was formerly, before the days of chloroform, a favourite one with surgeons, on account of the celerity with which it could be performed. It was then done by the transfixion method, and was particularly applicable to those parts of the limbs, the upper arm and thigh, where there is only one bone. The operation is performed with a long sharp-pointed knife. The surgeon, standing on the right side of the patient, seizes the soft parts of the limb in the fingers and thumb of the left hand, and raises them from the bone. He then transfixes the limb just below the spot where the saw is to be applied (fig. 429), passing his knife close in front of the bone, and carries it downwards and outwards, making as long an anterior flap as is judged necessary. He now releases the soft parts held in the left hand, reintroduces the knife at the same spot, but now passes it behind the bone and fashions his posterior flap by cutting downwards and backwards. He then retracts the soft parts a little, and saws through the bone. In this operation the soft parts are formed of all the tissues of the limb. The great objection to it is that the vessels are cut obliquely, and are therefore more difficult to secure efficiently. The flap operation may be variously modified: the flaps may be made of unequal length; only one flap, anterior or posterior, may be formed; lateral flaps, instead of antero-posterior, may be made; or if the surgeon desires to fashion his flaps of skin only, he modifies the operation by cutting from without inwards, instead of making the flaps by transfixion, and under these circumstances may form his flaps of any shape which he desires. He makes his incisions through the skin, and divides the parts from without inwards in any direction he chooses, so long as he secures sufficient coverings for the bone. It is on these lines that the surgeon of the present day operates, selecting what may be characterised as a combination of the flap and circular methods.

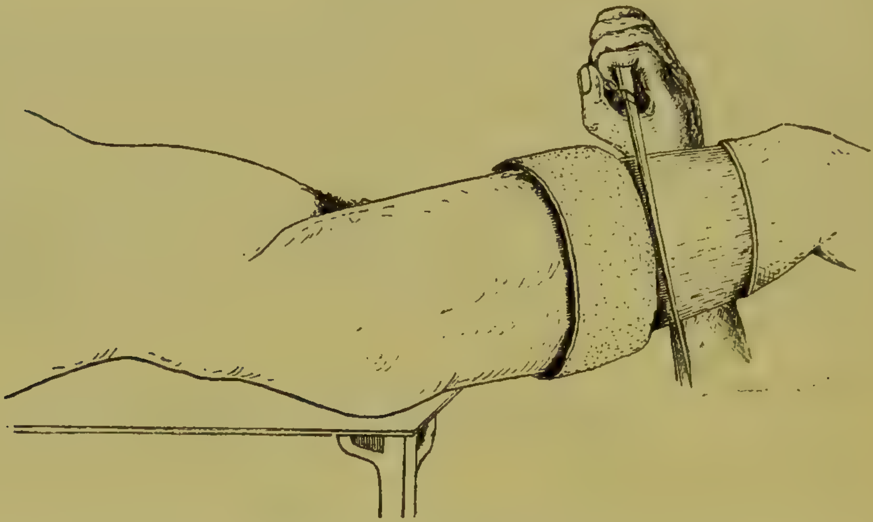

FIG. 428.—Circular amputation of the thigh: the skin and subcutaneous tissue have been reflected, and a circular sweep of the muscles is about to be made.

The first part of the operation is by the flap method. The flaps, consisting of skin and subcutaneous tissue, are cut from without inwards ; they are rectangular in shape, with rounded corners, and are of unequal length, the anterior being the longer, two-thirds the diameter of the limb ; the posterior the shorter, being half the length of the anterior. By this means the anterior flap is made to cover the end of the bone, and the cicatrix lies behind it and is in no danger of contracting adhesions to it ; and, moreover, the wound being in the most dependent position, more efficient drainage is secured. After these rectangular flaps have been formed and dissected up, the rest of the operation is performed by the circular method : one sweep of the knife divides the superficial muscles, and a second sweep the deeper ones at a slightly higher level, and the bone is then sawn through.

Another modification of the flap operation which requires mention is known as *Teale's amputation.* It consists in raising up a long anterior rectangular flap, which must be square, and equal in length and breadth to half the circumference of the limb at the point where the division of the bone is intended to be made. The flap must consist of all the tissues down to the bone. The posterior flap is also rectangular, but is only one-fourth the length of the anterior ; it includes all the soft parts down to the bone, including the large vessels and nerves. The advantages claimed for this operation are : (1) a complete covering for the bone, containing the large vessels and nerves, so that sloughing is not likely to take place ; (2) freedom from tension ; and (3) a dependent position of the wound. But it infringes one of the fundamental rules of amputation, in sacrificing more tissue than is absolutely necessary, on account of the length of the anterior flap.

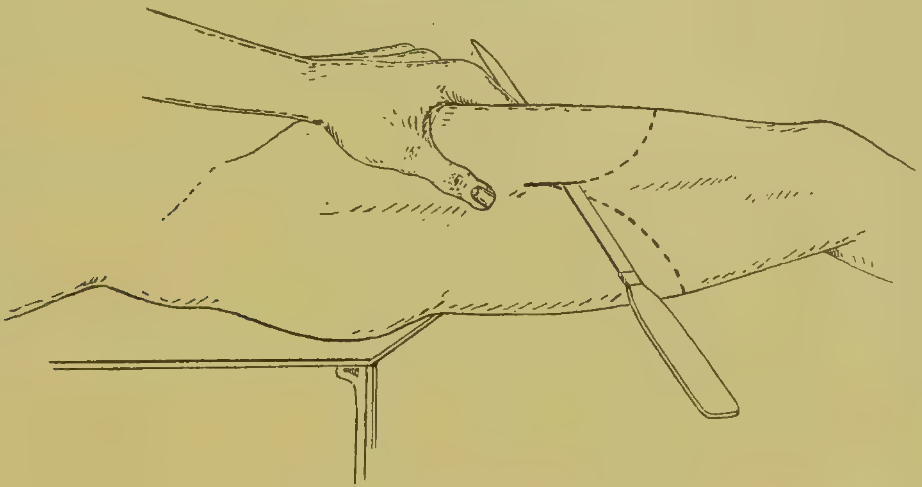

FIG. 429.—Flap amputation of the thigh by transfixion.

3. The **oval** or **racquet-shaped method** (fig. 427, C).—This method of amputation is mainly applicable to removal of the whole limb at the hip or shoulder joint. It is also used in amputation of the fingers and toes. It may be regarded as a modification of the circular amputation. It consists in a circular or oval incision through the skin, some little distance below the joint where disarticulation is going to be performed, and a longitudinal incision from the point where the circle is completed, on one side of the limb, over the joint, to facilitate its exposure. The angles where the circular and longitudinal incisions meet are rounded off, so as to give the whole incision somewhat the shape of a racquet.

GENERAL CONSIDERATIONS

Amputation may be required for injury or disease. When performed for injury, it may be either *primary*, when the operation is performed immediately after the receipt of the injury, before any febrile disturbance is set up; or *secondary*, when it is undertaken at a time more or less remote from the date of the injury, and at least twenty-four hours after its infliction. Formerly it used to be the custom to divide this latter class of cases into *intermediate*, those which were undertaken during the high febrile state which accompanied septic absorption before granulations had formed; and *secondary*, those which were performed after the fever had subsided; but this subdivision has fallen into disuse.

Asepticity.—The greatest care must be observed not only to render the part to be operated upon as aseptic as possible, but also to maintain the strictest asepticity during the performance of the operation, as the dangers of septic absorption are very great, inasmuch as muscular and cellular planes are freely opened up and the medullary canal of the bone exposed. This is not always an easy matter in a primary amputation; but the washing and scrubbing, in order to get rid of all dirt and superfluous epidermic accretions, should be as thorough as possible, and a little extra time is well spent in doing this.

Hæmorrhage.—In amputations it is essential that the surgeon should avoid all unnecessary loss of blood. In order to do this he must take some means to render the limb ex-sanguine during the performance of the amputation, until he can secure the cut vessels by ligature or otherwise. This is generally most easily done by elevating the limb for a few minutes, and then applying an elastic cord around it above the point where it is proposed to remove it. It is desirable to fold a few thicknesses of gauze around the limb under the elastic cord to prevent chafing, and the cord must be soaked in a solution of carbolic acid before use. It is obvious that in some amputations, such as those at the hip and shoulder joint, this plan cannot be adopted. In hip amputations, the abdominal tourniquet of Lord Lister, the rectal lever of Davy, or the elastic compressor of Jordan Lloyd may be employed; and in disarticulation at the shoulder the best plan of restraining hæmorrhage is digital compression of the subclavian artery against the first rib.

Other plans have been devised for diminishing the loss of blood, and at the same time getting rid of the blood which otherwise constantly oozes from the wound, even when a tourniquet has been applied. The principal one of these is Esmarch's bloodless method. This consists in applying an elastic bandage spirally around the limb from the distal extremity upwards, to the point at which the elastic tourniquet is intended to be applied. This drives all the blood out of the limb; and when an elastic cord is applied over the last turn of the bandage, and the latter removed, the limb will be found to be absolutely bloodless, and not a drop of blood will flow in the course of the operation. After the limb is removed, all cut vessels can be easily seen and tied, and the elastic cord is then removed. Unfortunately, the condition of anæmia which has been induced is followed by a condition of hyperæmia, and all the arterioles and capillaries which are too small to ligature become dilated and ooze freely, and very often as much blood is lost as if no Esmarch's method had been used. This may be obviated, it is true, to a very great extent by tying all vessels that can be seen, and then, after the introduction of a drainage tube and suturing the wound, applying a large dressing of gauze and wool, and carefully bandaging the stump and maintaining it in an elevated position. But under these circumstances the bag of the stump becomes filled with blood, which may interfere with primary union. Then, again, Esmarch's method is not applicable to all cases; as, for example, cases of gangrene, or where there is any purulent infiltration. And, moreover, certain evils are said to arise occasionally from its use: paralysis, from pressure on the nerves, especially in the arm; sloughing of the flaps, or even gangrene of the whole stump. Esmarch's bloodless method, however useful it may be in some operations—such as nerve suturing, where a delicate dissection has to be performed to find the nerve—is not to be recommended in amputations.

After the limb has been removed, care should be observed to tie every vessel of any size, so as to prevent reactionary hæmorrhage. After all visible vessels have been tied, the elastic cord should be taken off, an assistant being prepared to compress the main artery, in case any vessel of considerable size has been overlooked: and the surgeon should wait a minute or two, until the circulation in the stump is completely re-established, before proceeding to close his wound. It is one of the principles which should always be observed in amputations, to make the wound as thoroughly dry as possible by a complete arrest of all hæmorrhage.

Fashioning the flaps.—Three grand principles should always be present in the mind of the surgeon in fashioning his flaps: (1) to make them sufficiently large to afford an adequate covering without tension; (2) to arrange them in such a manner that the cicatrix shall not be situated over the end of the bone; and (3) to provide for efficient drainage.

To make sufficient covering.—In deciding on the size of his flaps the surgeon must bear in mind that he is dealing with contractile structures, and that therefore the flaps must be considerably larger than would be necessary in non-contractile tissues. The natural tendency of the young surgeon is to make his flaps too short, and when he comes to bring them together he finds to his dismay that he can only do so by using some force and producing tension on his sutures. This is bad. It sets up a condition of unrest, which perpetuates the slight inflammation necessary for healing, and may lead to untoward results. I have often heard the late Sir Prescott Hewett say 'that he had never had to regret making his flaps too long, but that he had often regretted making them too short.' And the saying is one well worth bearing in mind. As long as the flaps are sufficiently ample to cover the stump without tension at any part, it does not so much matter what their shape is, or whether they are antero-posterior or lateral, or whether there be one or two; though, as a rule, two are preferable to one, since if there is only one it must necessarily be of such a length that there is always a danger of its extremity sloughing from deficient blood supply. When two flaps are made, it is desirable that they should be of unequal length, so that the line of the cicatrix may not be over the end of the bone; and this is especially so in the lower extremity, where the weight of the body has to be borne on the stump. If the cicatrix is just over the bone, this structure is pressed upon and often causes so much pain that the patient is unable to wear his artificial limb; and in some cases the cicatrix may become adherent to the bone, and thus greatly increase his disability.

In determining which flap shall be the longer, it is generally desirable, in antero-posterior amputations, to make the front one the longer of the two. This provides a more dependent opening and more efficient drainage. In some cases—as, for instance, in a Syme's amputation—this cannot be done, for, on account of other reasons, the posterior flap is necessarily the longer. When this is so, the difficulty in drainage may be overcome by making a buttonhole in the posterior flap, through which a drainage tube can be inserted.

Sawing the bone.—After the flaps have been fashioned, the next step in the operation is sawing the bone. When the bone has been exposed, the periosteum should be incised, about an inch below the point where it is intended to make a section, by a circular sweep of the knife. The periosteum should then be raised from the bone to this level with an elevator, and turned upwards while the bone is sawn. As soon as the limb is removed, the sleeve of periosteum is turned down again over the cut surface of the bone and fixed there with a catgut suture. This proceeding is especially desirable in amputation in children. Bier, of Kiel, suggests taking up a thin slice of the bone with the periosteum and turning it up over the sawn ends of the bone in amputations of the leg. After having made his flaps, he saws through the bone at the apex of the longer flap, leaving some inches of bone protruding when the flaps are retracted. He then cuts off a quadrangular flap, consisting of periosteum and a thin slice of bone from the internal surface of the tibia, and turns this over the ends of the bones, after they have been sawn off at their proper level, and secures it with a suture. While the bone is being sawn the soft parts must be carefully kept out of the way by an assistant. Formerly retractors were used for this purpose, but they are scarcely ever required; never, if the parts cut through are healthy. The division of the bone should be made with a broad-bladed saw with finely set teeth, and the section should be made by placing the heel of the saw on the bone and drawing it towards the point for the whole length of the instrument; this will make a preliminary groove, and then, by steadying the saw with the thumb nail, the section is rapidly completed by drawing the instrument fairly from heel to point at each stroke. While the bone is being sawn the assistant who is holding the limb must be careful to hold it steady, neither elevating nor depressing it, but drawing it straight away from the body. If he elevates it he will lock the saw; if he depresses it he will splinter the bone. If any splintering has taken place, or the bone is sharp and likely to produce an injurious effect on the soft parts of the flap, it must be trimmed off with cutting bone forceps.

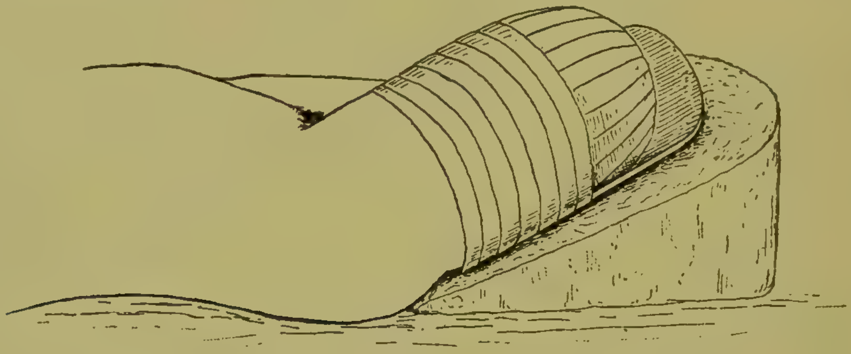

FIG. 430.—Arrangement of stump after amputation.

All bleeding vessels having been secured, the wound must be dressed. It is well in all cases of amputation to use a drainage tube for twenty-four or forty-eight hours. A piece of drainage tube should be inserted into each angle of the wound. This is better than having one long piece passing across the wound from one angle to the other, as they are more easily withdrawn. The flaps, having been well sluiced with corrosive sublimate solution, are brought together by three or four deep silkworm-gut sutures, which act as mainstays, and the whole length of the wound is then accurately adjusted with a continuous horsehair suture. All blood and fluid having been carefully expressed from the bag of the stump, the gauze is applied, and over this a very thick layer of salicylic wool, and this is carefully bandaged on so as to make firm elastic pressure on the flaps and prevent any cavity being left between them. The stump is then immobilised by an accurately adjusted splint, which is supported by a stump pillow (fig. 430).

The chief **complications** which are likely to arise in the subsequent course of an amputation are shock, hæmorrhage, and a septic condition of the stump.

Shock is liable to occur in cases of primary amputation, where the patient has suffered from other injuries or has lost a considerable quantity of blood: in old, weakly, or exhausted subjects, or young children, and in the major amputations, such as disarticulation at the hip joint. The surgeon must be prepared for this, and must treat the case on the lines laid down above (page 41).

Hæmorrhage, either reactionary or secondary, may occur, but is and ought to be very rare nowadays. Reactionary hæmorrhage is almost unknown in the present day after amputation, owing to the greater deliberation with which amputation can be carried out under anæsthesia. Secondary hæmorrhage is also very uncommon, owing to the use of aseptic ligatures, but it may occur in old people, where the arteries are rigid and calcareous. Should it occur, the artery must be ligatured in continuity at a higher level, the stump opened up, all clots removed, and the wound stuffed with gauze and firmly bandaged.

Septic conditions are prevented by due attention to antiseptic precautions, and cases of profuse suppuration and sloughing after amputation are now infinitely rare. Occasionally, however, in cases of primary amputation, in consequence of the surgeon's endeavour to preserve as much of the limb as possible, bruised tissues may be kept, which may subsequently slough ; or, owing to a partial failure in the antiseptics, a little local suppuration may occur which may delay the union of the wound. In some cases a spicule of bone may necrose and a sinus form, leading down to a little bare bone at the end of the stump.

STUMPS

Upon examining a healthy stump a year or so after the amputation, it will be found to consist of a mass of condensed fibro-areolar tissue, in which the structures which composed it are barely discernible. The bone will be found to be atrophied, its compact layer thinned, and its cancellous tissue in the centre converted into yellow fat. The extremity of the bone will be covered with a layer of compact bone, which seals the end of what was originally the medullary canal. All trace of muscular tissue will be gone, and its place taken by the mass of fibro-areolar tissue at the end of the stump ; higher up, the muscular tissue will be found gradually merging into this cicatricial mass. The blood-vessels may also be traced into this mass, converted into fibro-cellular cords up to their first collateral branch ; and the nerves in the same way may be traced into it, and will usually be found terminating in bulbous extremities, consisting of a rounded mass of fibrous tissue, in which are seen nerve fibres twisted on each other so as to form a convoluted skein.

Conical stumps.—A stump may sometimes become pointed or conical, and this may arise from several different causes. In young children it is sometimes unavoidable, and is due to subsequent growth of the bone after the amputation of the limb. This is especially the case in amputations of the arm, because the growth of the humerus is principally from the upper epiphysial cartilage. It not infrequently happens that, two or three years after an amputation of the arm in a child, the end of the bone may be seen protruding a couple of inches or so from the stump, covered only by thin skin and requiring removal. I have had to perform this operation twice in the same stump ; the second operation being done after an interval of six years from the primary amputation. A conical stump may also be produced by cutting the flaps too short, or not sufficiently retracting the soft parts during the section of the bone ; it may be caused by the soft parts, which have been the seat of inflammation before the amputation, contracting during the process of healing, or it may arise from extensive sloughing of the flaps.

When a stump is conical, the end of the bone presses against the skin and may become adherent to it. The skin is thinned, often eczematous, or a chronic ulcer forms on it. It is the seat of great pain when pressed upon, so that the patient is unable to wear his artificial limb. Eventually, where the irritation has been long-standing, epithelioma may attack the stump. The treatment of this condition is to make a longitudinal incision, on the side of the limb away from the main vessels, and saw off the lower end of the bone and remove it.

Neuralgia of stumps.—In all cases the divided ends of the nerves become more or less bulbous; but occasionally a considerable enlargement forms in connection with them, and when subjected to pressure they are exceedingly painful. Sometimes an ascending neuritis extends to the nerve roots, and even to the spinal cord, and the stump becomes the seat of intense pain and convulsive twitchings. In these cases the bulbous ends of the nerves should be excised, and if there is any neuritis the proximal ends should be well stretched.

SPECIAL AMPUTATIONS

The necessary limitations of space prevent me from doing more than describing in the briefest possible manner the amputations which are most frequently performed in removing different parts of the limbs, and many well-recognised and useful plans will have to be omitted altogether. But if the surgeon will bear in mind the broad principles of the three operations, by the circular, flap, and oval methods, which have been described above, and will take care always to secure sufficient covering for the ends of the bone, he cannot go far wrong in amputating by any mode he may think fit. And, indeed, in some cases of amputation for primary injury he is obliged to discard all rules and fashion his flaps as best he can from the uninjured tissues which have been left.

Removal of the upper extremity, including the scapula and the greater part of the clavicle (*Interscapulo-thoracic amputation*).—This operation is performed chiefly for growths which cannot be removed by an amputation at the shoulder joint. It has been recently done in several instances in cases of cancer of the breast, where the disease has recurred in the axilla and has caused great œdema of the arm and excessive pain from pressure on the main vessels and nerves. It is usually done by what is known as Berger's method. As an essential preliminary to the operation, the subclavian artery and vein are ligatured. The patient is brought to the edge of the table, so that the scapular region projects beyond it, and an incision is made down to the bone, over the clavicle, from the sterno-mastoid insertion to the acromio-clavicular joint. The clavicle is then isolated at the inner extremity of the incision, and a broad director being placed beneath it to protect the vessels, it is sawn through in this situation. Its outer end is then seized with lion forceps, and raised so as to free it from subjacent parts, and it is again cut through just internal to the coraco-clavicular ligaments. The middle third of the bone is thus removed, and the subclavius muscle will be exposed. It is divided at the inner end of the section of the bone, and turned outwards, thus exposing the subclavian vessels. These are isolated, tied in two places, and divided between the ligatures, the artery, if possible, being tied first. The suprascapular artery and vein should also be secured at this stage of the operation, and also the cephalic vein, if it can be seen.

The amputation is now proceeded with. The arm being abducted so that the surgeon can stand between it and the trunk, an incision is made through the skin and subcutaneous tissues from the middle of the first incision to the point of junction of the anterior fold of the axilla to the arm. This incision is curved outwards so that it passes outside the tip of the coracoid process and down over the anterior border of the deltoid, external to the bicipital groove (fig. 431). It is then carried across the base of the axilla close to the arm, and downwards and backwards along the posterior fold of the axilla to the apex of the scapula. The flap of skin having been dissected inwards, the pectoralis major and minor are divided. The shoulder now falls away from the body, and the axillary space is freely exposed, and the cords of the brachial plexus are divided at the same level as the subclavian vessels. The cervico-dorsal flap is now made by rolling the patient over towards his sound side, and making an incision from the outer extremity of the clavicular incision, over the spine, to the angle of the scapula where it joins the anterior incision. The skin and subcutaneous tissues are reflected backwards as far as the vertebral border. The insertion of the trapezius is cut through. The scapula now falls away from the chest, and the remaining muscles attached to its superior and vertebral borders are divided. In severing the levator anguli scapulæ the posterior scapular artery will be cut and must be at once seized with clip forceps. No other vessel of any size will be wounded, except the suprascapular, which has been secured at an earlier stage of the operation. The tendon of the latissimus dorsi is divided near its insertion, and the whole limb removed.

The operation is necessarily attended by a large amount of shock, and there is also danger from hæmorrhage, especially where the vessels are enlarged on account of the growth. Entrance of air into the veins, which occurred in one case, is prevented, as a rule, by the preliminary ligature of the subclavian vein. For the most part, cases which have not succumbed to the initial dangers of shock and hæmorrhage have done well; but from the nature of the disease for which the operation is performed, recurrence is the rule rather than the exception.

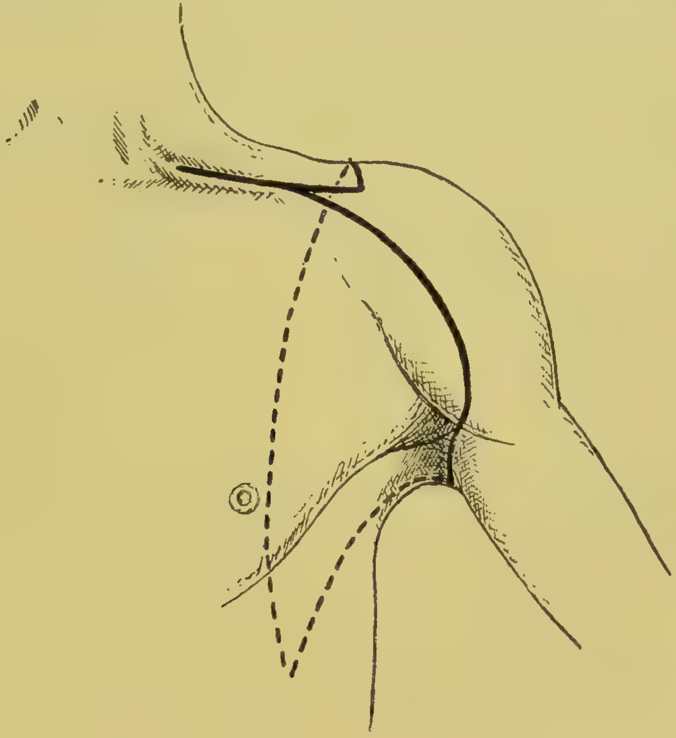

Fig. 431.—Lines of incision in Berger's operation for removal of the upper extremity.

Amputation through the shoulder joint is principally required for (1) injuries, such as gunshot wounds and other compound comminuted fractures into the joint; (2) for disease of the articulation unsuited for excision, or where excision has been performed and failed; and (3) for new growths.

There are many different methods of disarticulating at the shoulder joint, but probably the best, where the surgeon can choose his flaps, is that recommended by Spence, especially because it enables the operator to make his first incision and examine the joint, before he finally determines whether to excise or amputate. The method employed by Larrey is also a good one. The old plan of removing the upper extremity by a large deltoid flap, by transfixion, which was formerly the method adopted on account of the rapidity with which it could be performed, is now seldom resorted to.

As no tourniquet can be applied in these cases, the only method of arresting hæmorrhage during the operation is for an assistant to compress the subclavian artery against the first rib, either by his fingers or a compressor; but as this means is not very efficient, an assistant should be prepared to grasp the axillary vessels in the wound, if possible before they are divided.

Spence's method (fig. 432).—The patient is placed on his back so that the arm projects over the side of the table, and an assistant abducts the arm and rotates it outwards. An incision is made from a point midway between the coracoid and acromion processes, down the front of the joint to the level of the lower border of the tendon of the pectoralis major; this incision is carried deeply down to the bone, and divides some of the clavicular origin of the deltoid, and at its lower part the tendon of insertion of the great pectoral muscle. It also divides the anterior circumflex artery, which must be secured with a pair of forci-pressure forceps. At its upper part the incision has opened the joint, which can now be examined if judged necessary. From the lower extremity of this incision another is curved gently outwards, round the arm, to the posterior fold of the axilla, cutting deeply so as to divide the deltoid muscle a little above its insertion. A third incision is carried inwards with a gentle curve round the inner side of the arm to meet the external one; but this incision is carried only through the skin and subcutaneous tissues. The fingers of the left hand are now introduced under the outer flap, and the deltoid muscle is separated from the bone. No knife is to be used in doing this, for fear of injuring the posterior circumflex artery. In this way the head and upper part of the humerus may be fully exposed. The assistant now rotates the arm so as to bring the various capsular muscles into view; and the subscapularis, the long head of the biceps, the supraspinatus, the infraspinatus, and the teres minor are successively divided, together with the capsular ligament. The large deltoid flap is then well retracted and the knife passed behind the head of the humerus, keeping close to the bone to avoid wounding the posterior circumflex artery, and the arm removed by

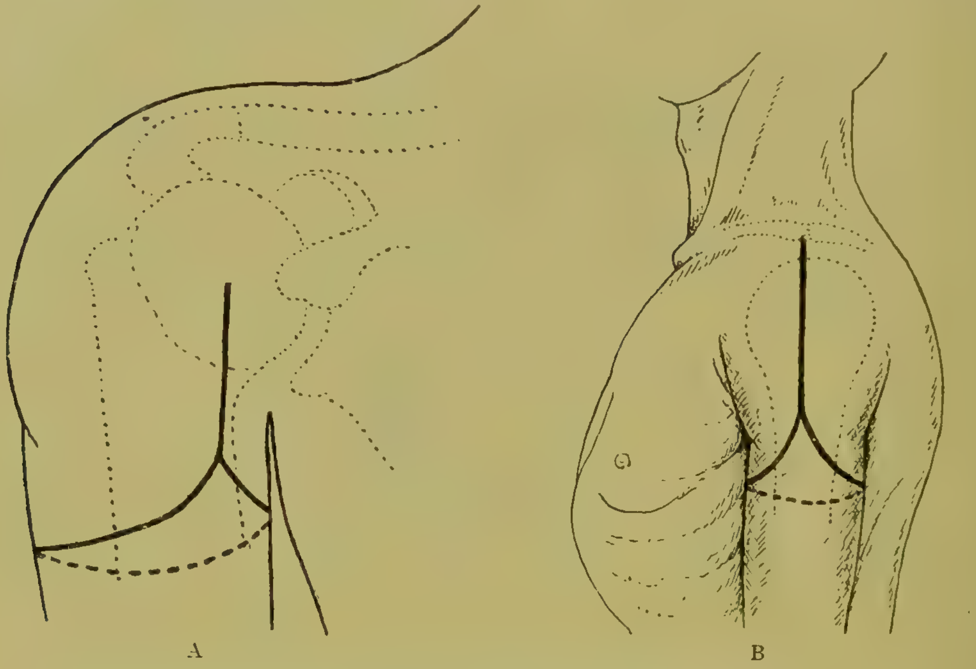

FIG. 432.—Spence's and Larrey's method of amputating at the shoulder joint.
A. Spence's method. B. Larrey's method.

dividing the remaining soft tissues on the axillary aspect. As this is being done an assistant grasps the soft parts on the inner side of the joint, so as to compress the axillary artery and vein before these structures are divided. This operation gives a full fleshy stump; the posterior circumflex artery is not injured, and disarticulation can be easily accomplished.

Larrey's operation (fig. 432).—This is an amputation by the oval incision, as in Spence's amputation; but the handle of the racquet is on the outer side of the arm. The patient is placed in the same position as in the preceding operation, with the arm and shoulder projecting over the edge of the table; but he is turned over towards the sound side, and is fixed in this position by pillows. An assistant compresses the subclavian artery, and the arm being held in a position of abduction, the surgeon introduces a strong knife immediately below the tip of the acromion process and carries it downwards over the outer aspect of the shoulder for about three inches, and then curves it gently inwards to the anterior fold of the axilla; from the extremity of the straight part of the cut he carries another incision, curved gently outwards, to the posterior fold of the axilla. These incisions divide everything down to the bone, including the posterior circumflex artery, which must be at once seized. The two flaps thus formed are then separated, and the bone and the outer aspect of the joint are exposed. A transverse cut is now made over the situation of the anatomical neck of the humerus, and the capsule and capsular muscles completely divided. While this is being done the assistant adducts the arm and prises the head of the bone outwards, so as to render tense the parts to be divided. The knife is now passed behind the head of the bone, and carried down the inner side of the humerus close to the bone; in its course it is followed by the fingers of the assistant, and the axillary vessels are compressed before they are divided. When the knife has reached the level of the first incisions it is turned towards the surface, and the main vessels and nerves, together with the skin between the ends of the first and second incisions, cut through, and in this manner the operation is completed.

This operation produces an excellent stump: it can be thoroughly drained, and the hæmorrhage is easily controlled during the operation; but it is inferior to Spence's method, because the posterior circumflex artery is divided, and because it cannot be employed in those cases where there is any doubt as to whether the joint should be excised or amputated.

Amputation by a large deltoid flap is now seldom resorted to. It used to be done by transfixion, by cutting from within outwards; but it may also be done by fashioning the flaps and cutting from without inwards. The advantage of the transfixion operation is the celerity with which it can be performed; but there are several objections to it. (1) It requires the leverage of the humerus; but this bone is often broken in cases requiring operation, or may break, if it is the seat of a malignant growth, during its performance. (2) It is often impossible to find enough healthy structure to fashion the large external flap. (3) It is usually attended with more loss of blood than the other operations; and (4) in cases of malignant disease encroaching on the shoulder it is impossible to perform the operation without leaving diseased structures. The large external flap is U-shaped, and is formed by introducing the knife on the right side, just external to the coracoid process, passing in front of the capsule and making it emerge beneath the root of the acromion, and cutting downwards and outwards, so as to form a flap consisting mainly of the deltoid muscle. On the left side the knife is introduced from behind. The flap is then raised and the joint opened, the capsule and capsular muscles divided, and the knife carried through the joint fashions the internal flap by cutting downwards and inwards from within outwards. The vessels are thus divided with almost the last stroke of the knife, and are at once seized by a watchful assistant.

Amputation of the arm.—The best method of performing amputation of the arm is by skin flaps, cut of unequal length, and circular through the muscles. The flaps may be either antero-posterior or lateral. I prefer the latter, as affording rather better drainage; but either plan forms a very excellent stump.

Amputation through the elbow joint is not often performed, many surgeons preferring to amputate through the lower third of the humerus; but nevertheless it possesses some distinct advantages. The long stump left is very useful, and well adapted for the application of an artificial limb: the end of the bone is covered by a large fleshy pad, and no bone is sawn through or medullary cavity opened up. The best mode of operating is by a long anterior and short posterior flap. The forearm is supinated, and a rectilinear flap with rounded corners is made by cutting from an inch below the internal condyle down the inner side of the forearm for three inches, then across the front of the forearm and up the outer side to a point an inch and a half below the external condyle. The posterior flap is fashioned in the same way, but is made only half the length of the anterior one. In dissecting up the anterior flap from the front of the joint, the skin and subcutaneous tissue are only raised for the first half-inch or so, and then the knife is carried more deeply so as to include muscular tissue. The posterior flap consists of skin and subcutaneous tissue only, and in raising it care must be taken not to score it with the knife. When the flaps have been raised to the level of the elbow joint the articulation is opened, preferably first on the outer side, and the disarticulation completed; the final stage of the operation consisting in separating the posterior ligament and the triceps from the olecranon.

Some surgeons prefer to perform the operation by skin flaps, the posterior being the larger, with a circular division of the muscles. It does not give such good results as the flap operation.

Amputation of the forearm is best performed by antero-posterior skin flaps and circular through the muscles. It is essential in removing the forearm to leave as long a stump as possible, and most desirable to make the section of the bones below the insertion of the pronator radii teres to the radius; otherwise the power of pronation and supination will be lost, and the utility of the limb very seriously impaired. In sawing the bones the limb should be held in a position of supination, so that the two bones may be sawn together.

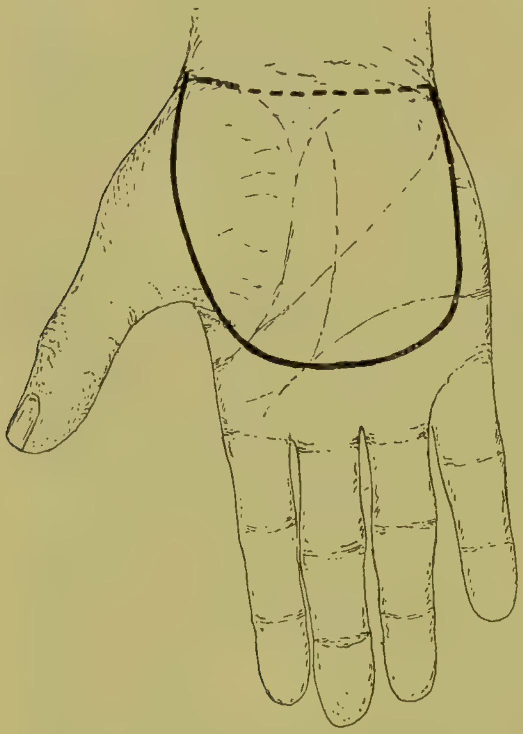

FIG. 433.—Amputation of the hand at the wrist joint by the long palmar flap.

Amputation through the wrist joint (fig. 433) is not often required, its employment being mainly confined to injuries of the hand and to cases of disease of the carpus in which excision is not thought desirable. It leaves a most excellent stump, with full powers of pronation and supination, and should always be performed when practicable. When done for injury, the flaps must be fashioned according to circumstances; but when the soft parts are not involved, and the surgeon can perform the operation *secundum artem*, the best operation is by a long anterior flap. The hand is held in a position of supination, with the thumb abducted, and an incision made from the styloid process of the radius, over the thenar eminence and down the radial border of the hand, to the anterior transverse crease of the palm; a similar incision is made from the styloid process of the ulna, over the hypothenar eminence, to a corresponding point on the ulnar side of the palm, and the lower extremities of the two incisions joined by a transverse one across the palm, the corners being rounded off. The flap thus formed is then dissected up as far as the level of the wrist joint, and is made to contain all the structures down to the bones. It is then turned backwards, and the flexor tendons and the large nerves divided at the level of the joint and removed; the other structures, including the palmar arches, are left. The hand being now pronated, a slightly convex incision is made across the back of the wrist from one styloid process to the other; the extensor tendons and the lateral and posterior ligaments of the wrist divided, and the hand removed. Where the soft parts are scanty this operation cannot be performed, and it may then be necessary to amputate by anterior and posterior flaps of equal length; but this operation does not yield such good results as those obtained by the long palmar flap.

Amputation of the thumb at the carpo-metacarpal joint is hardly ever required in practice; but it is a classical operation, and must therefore be described. It may be done by the oval method or by transfixion, the former being generally preferred.

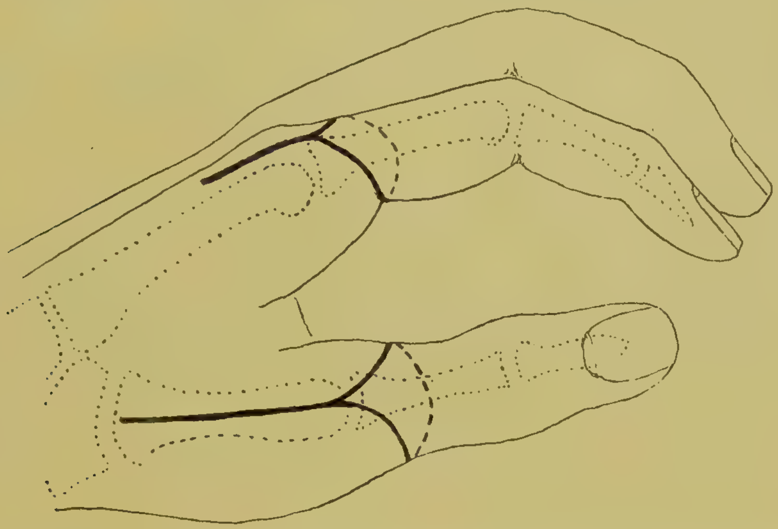

FIG. 434.—Amputation of the thumb at the carpo-metacarpal joint by the oval method, and of the index finger at the metacarpo-phalangeal joint.

The **oval method** (fig. 434).—The hand being in a position midway between supination and pronation, the surgeon grasps the thumb with his left hand and introduces the point of his knife over the back of the carpo-metacarpal joint, an inch below the styloid process of the radius, and carries it down the back of the metacarpal bone to the base of the first phalanx; he then sweeps it round the metacarpo-phalangeal joint, so as to make an oval incision. He then dissects the soft parts from the metacarpal bone, first on the inside and then on the outside, keeping close to the bone, until he reaches the carpo-metacarpal joint; this he opens, and by twisting, aided by a touch or two with the point of the knife, he disarticulates. In doing this he must bear in mind the close proximity of the radial artery and keep close to the bone.

In the **operation by transfixion** on the right side of the body, the hand is fully supinated and a sharp-pointed long bistoury is thrust into the web between the thumb and index fingers, carried through the thenar muscles, and made to emerge at the carpo-metacarpal joint; by cutting outwards, a semicircular flap is formed. The hand is now pronated, and an incision made obliquely across the metacarpal bone from one extremity of the first incision to the other. The flaps being held out of the way, the bone is cleared from the soft parts, the carpo-metacarpal joint opened, and disarticulation completed in the same way as in the oval amputation. On the left side the proceeding is reversed: the dorsal incision is first made, and then the palmar flap by transfixion.

Amputation through the metacarpo-phalangeal joint of the thumb.—In dealing with the thumb the endeavour of the surgeon should be always to save as much as he can. Even preserving half the metacarpal bone will leave a more useful member than removing the whole bone, and therefore amputation at the metacarpo-phalangeal joint is an infinitely better operation than the one just described, and ought always to be performed when practicable. When the metacarpal bone is left the remaining fingers can be approximated to the stump, and the hand used for grasping even small objects in a way which it cannot do when the metacarpal bone is removed.

Amputation at the metacarpo-phalangeal joint may be performed by a racquet-shaped incision, taking care to carry the oval incision well in front of the head of the metacarpal bone, so as to leave plenty of tissue to cover the bone. The tendency in this operation is to cut the flaps too small.

Amputation through the terminal joint of the thumb is performed in the same manner as in the other fingers.

Amputation of the whole finger through the metacarpo-phalangeal joint.—The manner in which these amputations are performed differs as to whether it is the middle and ring fingers or the index and little fingers which require amputating.

The *middle* and *ring fingers* are amputated by an incision which commences on the dorsal aspect of the metacarpal bone, about three-quarters of an inch above its head, and is carried downwards and to one side of the joint till it gets well on to one side of the phalanx, and is continued round this till it reaches the palmar surface, and it is then made to converge to the middle line opposite the base of the first phalanx. A similar incision, commencing at the same point, is made on the opposite side of the joint. In this way two lateral flaps are formed. The incisions are made deeply, dividing the extensor tendons at their commencement, and all the soft parts down to the bone on either side of the joint. The finger is now flexed and the joint opened on its dorsal aspect, the lateral ligaments divided, and the finger disarticulated with a touch or two of the knife. The flaps should be sufficiently long to meet easily over the head of the bone. Some surgeons, instead of making lateral flaps, amputate by the oval method. The incision is commenced at the same point, but is carried straight downwards over the head of the bone and then swept circularly round the base of the phalanx. The objection to this method is that it leaves an unsightly fold of skin on the palmar aspect when the edges of the incision are brought together.

This is the usual operation which is performed; but in the case of a lady, where strength is not required and appearance is of importance, the head of the metacarpal bone should be removed. The incision must then be commenced higher up; and after the finger is removed the head of the bone must be sliced off with bone forceps, and the heads of the metacarpal bones on either side can be approximated, and thus the ugly gap left by the removal of the finger is done away with.

The *index* and *little fingers* are best amputated at the metacarpo-phalangeal joint by the oval method (fig. 434), the straight part of the incision being made over the dorsum of the metacarpal bone and the joint. After the finger is removed, half the head of the bone is cut off obliquely, so as to shape it to the tapering form of the hand.

Amputation through the first interphalangeal joint is not a desirable operation, since the first phalanx, which is left, is practically useless and very much in the way, as there are no tendons inserted into it to flex it when the other fingers are flexed; if therefore the base of the second phalanx into which the flexor sublimis digitorum is inserted cannot be preserved, amputation should be done at the metacarpo-phalangeal joint.

Amputation of the terminal phalanx (fig. 435).—This is best performed by a long palmar flap cut from the pulp of the finger. The hand is pronated, and the surgeon, holding the terminal phalanx between his finger and thumb, defines the joint between the second and third phalanges. This is best done by flexing the terminal phalanx to a right angle with the rest of the finger, and drawing a straight line down the lateral surface of the second internode, midway between its dorsal and palmar surface. This line, continued on, will mark the position of the joint. The operator commences his incision well on the lateral aspect of the joint and carries it over the dorsum to the lateral aspect of the other side. This incision should divide the lateral ligaments and open the joint on its dorsal aspect. The knife is now carried through the joint, and as soon as it has traversed it the cutting edge is turned towards the operator, and a flap formed from the pulp of the finger by cutting towards its tip.

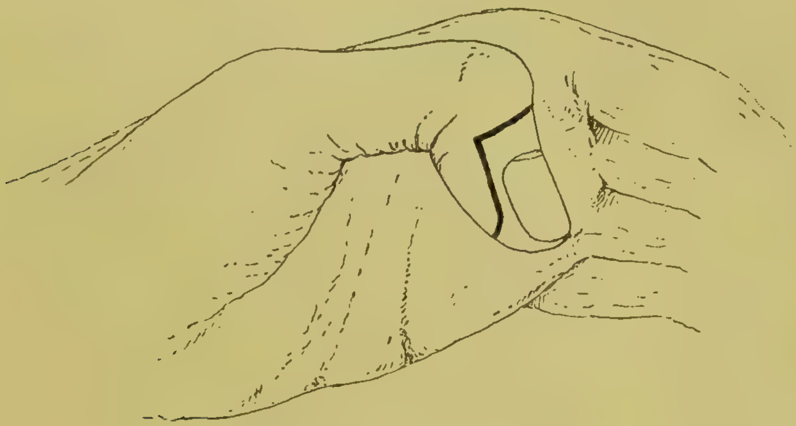

FIG 435.—Amputation of the thumb at the terminal joint.

AMPUTATIONS OF THE LOWER EXTREMITY

Amputation through the hip joint is the most formidable of all the amputations. It is done most frequently for advanced hip-joint disease, especially in those cases where excision has failed. It is also occasionally performed in cases of sarcoma of the femur. Primary amputation for injury, such as extensive gunshot wound of the thigh, or compound comminuted fracture of the femur, with great laceration of the soft parts, is not a successful operation ; and in all probability the patient would have a better chance of life by arresting hæmorrhage, thoroughly cleansing the parts and keeping them as aseptic as possible, and later on doing a secondary amputation if necessary.

The operation of amputation at the hip joint was formerly always performed by the flap operation by transfixion, a long anterior and short posterior flap being made. This operation was attended by a great loss of blood, and was in many cases immediately fatal. It has now been practically abandoned, and the operation known as Furneaux Jordan's, or some modification of it, is usually practised. All of these operations are based on the racquet-shaped principle. Hæmorrhage is one of the most serious dangers which has to be encountered, and various measures have been suggested and employed in order to control it. When the operation is performed by Furneaux Jordan's method, no plan of controlling the hæmorrhage is so successful as that introduced by Jordan Lloyd. Some surgeons, however, prefer to ligature the femoral vessels prior to cutting them through, and they then modify Furneaux Jordan's operation in a manner which will be described in the sequel. Jordan Lloyd's method of controlling the hæmorrhage is by means of an elastic compressor. The limb is emptied of blood by vertical elevation for a few minutes, and then a piece of elastic bandage is applied. The bandage must be very strong, so as to require the full strength of the surgeon to stretch it to double its length, and must be at least two yards long. A firm rib-roller is laid vertically over the femoral artery as it crosses the pubic bone, and then the middle of the bandage is laid on it, and one end of it is carried under the crutch, so that it lies midway between the tuber ischii and the anus, and is brought up under the buttock ; the other end is carried outwards over the anterior superior spine, and the two ends are drawn steadily upwards and outwards by an assistant to a point about the middle of the crest of the ilium, with sufficient tightness to arrest the circulation of the vessels below.

The other plans of controlling the hæmorrhage can only be briefly alluded to. (1) Lord Lister's tourniquet (fig. 97) is reliable, but involves a danger of bruising the intestine or mesentery, and sometimes interferes with the respiration. (2) Davy's lever is also not devoid of danger. It consists of a gum-elastic cylinder, which is introduced into the rectum until it lies across the common iliac artery of the side to be operated on. Up the cylinder is now passed an ebony rod with a handle. By raising this handle, the extremity of the cylinder is depressed and compresses the vessel, arresting the circulation of blood through it. (3) The abdominal aorta may be compressed by placing a large pad, the size and shape of an ordinary pin-cushion, over the vessel, and underneath the loins a board which projects on either side. A broad elastic bandage is then laid over the pad, and being stretched so as to force it down on to the aorta, is turned two or three times round the board so as to hold the bandage taut. The apparatus is cumbersome, and the projecting board is in the way of the surgeon and his assistants. (4) The abdominal aorta or the common femoral may be compressed by a trustworthy assistant in the following manner. An assistant stands on the left side of the patient on a high stool, so that the knee joint is about on a level with the operating table, and with his right side against the table. He then places the closed fist of his right hand on the patient's abdomen, so that the knuckle of the index finger is just above and to the left of the umbilicus, and standing on his left foot, with the right leg crossing in front of the left, he leans by means of the closed fist on the patient's abdomen, and can exert sufficient pressure to entirely arrest the flow of blood through the aorta without any great amount of fatigue, and for any length of time which may be required. This plan is strongly advocated by Macewen, but it possesses the same disadvantage as the others, that it tends to embarrass the breathing ; and if the patient happens to make any violent expiratory effort, such as vomiting or coughing, the hand is temporarily raised from the vessel. Compression of the common femoral by the fingers, aided by a padded key, is not very reliable, though it may be employed in children. (5) Wyeth, of New York, has recently introduced a 'bloodless method' of amputating at the hip. He renders the limb exsanguine by elevation or by Esmarch's bandage, and then encircles the thigh close to the pelvis by an elastic cord half an inch in diameter, which is made to pass round five or six times. This cord is prevented from slipping by the introduction through the tissues of stout steel needles : one inserted for three inches into the tissues immediately below the anterior superior spine of the ilium ; the other on the inner side of the thigh, through the adductor muscles, and passing from the inner side of the saphenous opening to emerge an inch below the tuber ischii.

Furneaux Jordan's amputation (fig. 436).—The patient is brought to the end of the table, so that the pelvis rests on the extreme edge, and the circulation is controlled by Jordan Lloyd's plan. The surgeon, standing on the outside of the limb to be amputated, makes a circular sweep through the skin and subcutaneous tissues about the middle of the thigh, or a little below this point, and reflects them for about two inches, and then divides the muscles circularly down to the bone. If the amputation is being performed for a case of failed excision, the bone is now sawn through and the limb removed ; if excision has not been performed, this should not be done, as the femur will be required for leverage in disarticulating. In either case the vessels on the face of the stump are secured before the rest of the operation is proceeded with. When this has been done, a vertical incision is made up the outer side of the thigh over the bone, to a point midway between the crest of the ilium and the top of the trochanter, commencing at the end of the stump. This incision should go through the periosteum, and if possible this should be peeled off the bone, with the muscles. In cases of old hip disease in children, where inflammatory changes in the bone and periosteum have been going on, this is comparatively easy, the only difficulty being at the linea aspera. Where the amputation is being performed for a new growth, the periosteum must be left and the muscles separated from it. In amputation after excision the remains of the bone are thus easily shelled out and the operation completed ; but where the head of the bone is still in the socket, disarticulation must be performed. The joint must be opened by cutting on the neck of the bone and dividing as much of the capsule as possible ; and the assistant who is holding the limb strongly everts and rotates it outwards, and forces the head out of the socket, when a few touches of the knife secure its liberation.

If the patient is in a condition to stand it, after all vessels have been secured, any existing sinus should be laid open and scraped, and a solution of chloride of zinc (gr. xl to ℥j) freely applied. Drainage must be provided for, and a few sutures rapidly applied, and a large antiseptic dressing with plenty of wool bandaged on with firm pressure. If the acetabulum is diseased, this must also be attended to. The raw surface in this operation is necessarily very extensive, but it has the advantage of being in a good position, not likely to be contaminated by septic matter from the anus or genital organs.

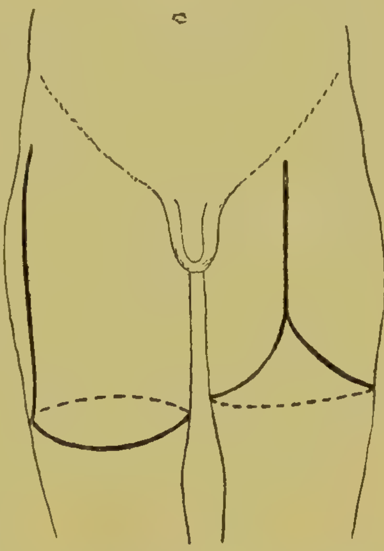

FIG. 436.—Amputation through the hip joint : on the right side by Furneaux Jordan's method ; on the left side by a modified form of the same operation.

Those surgeons who believe that the best way of preventing hæmorrhage is to secure the main vessels before dividing them, perform the operation in a somewhat different way, by means of an anterior racquet-shaped incision (fig. 436). The patient being brought to the edge of the table, an incision is made down the front of the thigh, over the course of the main vessels for about three inches, commencing at Poupart's ligament. It is then sloped downwards and inwards round the inner side of the thigh, so that it is about five inches below the perineum ; across the back of the thigh, and then along the outer side obliquely upwards, to reach the termination of the straight incision. The femoral vessels are now exposed, ligatured in two places, and divided between the two ligatures. The muscles are separated from the outside of the thigh, the limb being rotated inwards to effect the division of the gluteus maximus muscle. The muscles on the inner side of the thigh are then separated until the capsule is reached, and this is opened by a transverse cut ; and by strongly everting and rotating the limb outwards, disarticulation is effected, and the limb removed by dividing the structures at the back of the joint, including the sciatic vessels and nerves. The objection to this operation is hæmorrhage from the internal circumflex artery, which is divided upon freeing the structures on the inner side of the neck of the bone, at the bottom of a deep wound, where it is very difficult to secure. The other big vessels—the external circumflex and the sciatic—can generally be easily caught and clipped as soon as divided.

The object in leaving the periosteum, as far as possible, in Furneaux Jordan's amputation, is in the hope that some new bone may be formed from it. Shuter, who was the first to suggest leaving the periosteum, succeeded in obtaining a firm resisting structure in the centre of the stump, which formed a fixed point from which the muscles could act, so that the patient could flex or extend, abduct or adduct his stump, and could communicate these movements to an artificial limb.

Amputation of the thigh.—The thigh may be amputated by any of the methods enumerated on page 1129; but the one which is most frequently adopted and which gives the best results is the flap amputation through the skin and circular through the muscles. The flaps are of unequal length, and may be either antero-posterior or lateral. The antero-posterior are to be preferred, as with lateral flaps the bone tends to protrude at the upper angle of the wound. Means having been taken to control the hæmorrhage, the surgeon stands on the right side of the limb to be amputated and makes a straight incision on either side equal in length to the diameter of the limb. The incision divides the skin and subcutaneous fat, and commences at the level at which the bone is to be sawn. The lower ends of these incisions are joined by a transverse cut across the front of the thigh, made in such a manner that the angles between the transverse and vertical cuts are rounded. The knife is then passed behind the thigh, and the two vertical incisions joined by a transverse cut through the skin at their centres. The angles of this flap are also rounded. The anterior flap is then raised, consisting at first of skin and subcutaneous tissue; but as the point at which the bone is to be divided is approached, a certain amount of muscle is included. The posterior flap is then, in like manner, dissected up, but should consist of nothing but skin and subcutaneous tissue. The muscles are divided by a circular sweep of the knife; an assistant retracts the soft parts, and the bone is sawn through, the periosteum having first been divided lower down and retracted.

Amputations immediately above the knee joint may be required in cases of disease of this articulation. The operation may be performed either through the condyles by Carden's or Gritti's method, or immediately above the condyles by Stokes's method.

Carden's amputation.—The surgeon stands on the right side of the limb, and places his forefinger and thumb on the two condyloid eminences of the femur. He then enters the point of his knife close to the finger, and carries it down the side of the knee, gradually sloping it towards himself, so that it crosses the front of the limb midway between the lower border of the patella and the tubercle of the tibia and up the other side. The large anterior flap thus marked out is then dissected up to the level of the centre of the patella. The knee is forcibly flexed by an assistant; this pulls the patella down, and the knife is introduced into the joint by a transverse cut immediately above this bone. The ligaments of the joint are now divided; as the knife passes between the bones, and divides the posterior ligament, it is turned downwards and made to cut its way out downwards and backwards, fashioning a posterior flap.[1] When the limb has been removed, the condyles of the femur are cleared and sawn off just below the adductor tubercle. The saw must be carried through the bone, parallel to the articular surface of the femur.

Gritti's operation is similar to Carden's, except that he retains the whole of the patella with the exception of its articular surface. The long anterior flap is made in the same way, but in dissecting it up he opens the joint below the patella, by a transverse cut through the ligamentum patellæ ; and, after dividing the ligaments of the joint, he cuts his posterior flap rather longer than is necessary in Carden's operation. After the limb is removed he saws off the cartilaginous surface of the patella, and makes his section of the femur at rather a higher level than in Carden's operation, dividing the bone above the adductor tubercle. When the anterior flap is drawn down and sutured to the posterior, the denuded surface of the patella is brought into contact with the denuded surface of the condyles, and it is hoped that union will take place between these two bones. There is, however, a strong tendency for the patella to tilt, and it has been advised that the two bones should be wired together. Others have advocated division of the quadriceps extensor. Stokes, in order to overcome this difficulty, suggested his modification of Gritti's operation. It consists in making the section of the femur half an inch above the condyles, when it is found that the patella falls readily into its place, and there is no tendency to tilt. Moreover, the section of the femur at this spot is more the size of the cut surface of the patella than when the section is made through the condyles.

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[1] This latter proceeding is a modification of Carden's operation, who cut straight outwards through everything, without making any posterior flap. It is found, however, when this is done, on account of the action of the hamstring muscles, the incision on the back of the thigh is retracted so much that the covering is insufficient.

Amputation through the knee joint (fig. 437).—There are several ways of amputating the leg through the knee joint, but there can be little question that the method suggested by Stephen Smith is the best, and it will therefore be the only one described in this work. The surgeon, standing on the right side of the patient, makes two lateral flaps by introducing the knife an inch below the tubercle of the tibia and carrying it in a semicircular manner to the centre of the joint behind, first on one side and then on the other, in such a manner that the flaps are about three and a half inches long ; the inner one being slightly longer than the outer one. He then dissects up the flaps, consisting of skin and subcutaneous tissue, to the level of the articulation ; divides the ligamentum patellæ, and keeping his knife close to the bone, separates the semilunar cartilages from the tibia. The flaps being well retracted, he divides the whole of the remaining structures at the level of the joint, and removes the limb. The object in preserving the semilunar cartilages is that they may fit like a cap over the end of the femur and prevent retraction. When union has taken place, the cicatrix is lodged behind in the inter-condyloid notch, and the condyles of the femur are provided with an excellent covering ; the patient bearing the weight of his body on the end of his stump, as in kneeling.

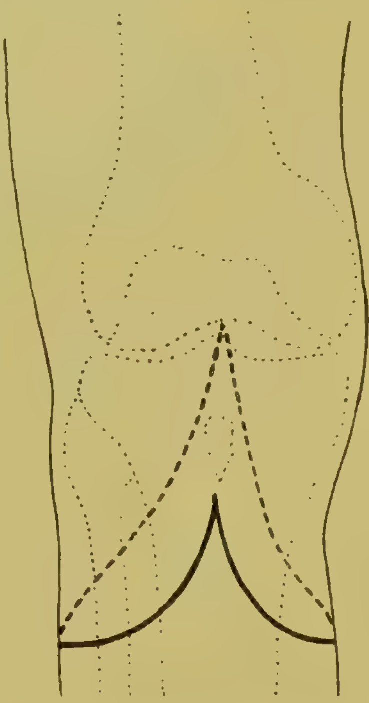

FIG. 437.—Stephen Smith's amputation through the knee.

Amputation of the leg may be performed at any part from immediately above the malleoli to a point a hand's breadth below the knee, which latter situation was termed by the older surgeons *the seat of election*. It may be performed by the circular method, which secures the section of the bones at a lower level than by any other operation ; by flaps through the skin and circular through the muscles, with flaps of unequal length ; or by flaps on the anterior surface by section from without inwards, and on the posterior surface by transfixing the parts and cutting outwards. None of these operations require any special description ; but there are two special points in connection with the section of the bones which require mention : one is to get rid of the prominent crest of the tibia from the lower end of the bone forming the stump, and the other to complete the section of the fibula before that of the tibia. The bones are to be sawn in the following manner: after the flaps have been formed, they are to be well retracted, and the saw is to be applied to the crest of the tibia, about three-quarters of an inch above the point where it is proposed to make a section of the bone, and an oblique cut downwards and backwards is made until the line of intended section is reached. The saw is then withdrawn and reapplied to the crest at the point which has been previously determined upon for the line of section, and the bone sawn through directly backwards. The wedge-shaped portion of bone formed between the two cuts will now be separated, and the prominent crest of the tibia removed. In sawing through the tibia, the fibula is to be divided at the same time. As soon as a groove has been formed in the tibia, the saw is applied to the fibula and the section continued; in consequence of the smaller size of the latter bone, its section is completed long before that of the tibia.

There is one amputation of the leg which has recently been spoken of very favourably by some surgeons, which requires special description. This is Farabœuf's amputation a hand's breadth below the knee joint.

Farabœuf's amputation (fig. 438) is performed by a large external flap, which is U-shaped, with limbs of unequal length. The flap is made by commencing the incision on the front of the leg, at the level at which it is intended to divide the bone—that is to say, a hand's breadth below the knee joint—and carrying it down the front of the tibia and round the outer side of the leg to its posterior surface, where it terminates at a point an inch and a half below the level of the commencement of the incision in front. The flap thus formed must be equal in length to the diameter of the limb at the point where the bones are to be divided. From the extremity of the incision behind, a transverse cut is made round the back and inner side of the leg to meet the incision in front, an inch and a half from its commencement. The external flap is then dissected up, separating all the tissues down to the bone and interosseous membrane; but care must be taken not to carry the dissection too high, so as to endanger the anterior tibial artery as it passes between the two bones above the upper border of the interosseous membrane. After the flap has been reflected, the rest of the tissues are divided by a circular sweep of the knife, the bones cleared and sawn through. In dissecting up the flap the muscles must be cut through obliquely, and it then forms a very efficient covering to the ends of the bones.

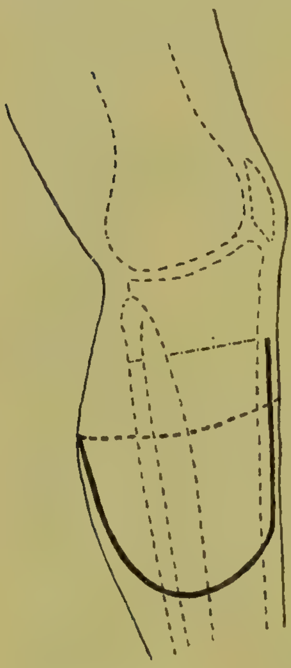

FIG. 438.
Farabœuf's amputation.

Amputations through the ankle joint (fig. 439).—**Syme's amputation** consists in a removal of the foot at the ankle joint, together with the lower end of the tibia and fibula. The operation is available in most cases of disease of the ankle joint and tarsus, and also in many cases of injury. It forms a most excellent stump, the tissues of the heel being capable of sustaining a considerable amount of pressure, so that the patient can usually walk almost as well as he could before the loss of his foot. The operation is thus performed, if we follow the directions of Syme: The patient lies on his back, with the foot projecting over the end of the table and elevated, and the surgeon is seated below the foot. He makes a transverse cut across the sole, from the tip of the external malleolus to the corresponding point on the opposite side, i.e. below and behind the internal malleolus. This incision is carried right down to the bone. He then inserts his thumb nail to the bottom of this incision, and guarding the soft parts with it, he dissects the flap backwards over the point of the heel and over its posterior surface until the tendo Achillis is reached. The anterior flap is then formed by making an incision, somewhat convex forwards, from one extremity of the first incision to the other. This flap is dissected up and the ankle joint opened ; the anterior and lateral ligaments are divided, and by the division of a few fibrous connections and the tendo Achillis, the foot is removed. The lower end of the tibia and fibula is now cleared and sawn off. If the amputation is for injury and the ankle joint is healthy, it will be sufficient to saw off the two malleoli, leaving the articular cartilage on the inferior surface of the tibia ; but if there is any disease in the ankle joint, a thin horizontal slice of the tibia, as well as the two malleoli, should be removed. In dissecting back the posterior flap, great care must be observed, by keeping the edge of the knife directed towards the bone, not to score it, otherwise the flap will be in danger of sloughing, a catastrophe which has sometimes happened, but which may always be avoided by care. Many surgeons prefer to reverse the order of proceeding, and no doubt by this means the operation is rendered easier. The flaps are first mapped out ; the anterior one is then made, the joint opened and disarticulation performed ; the os calcis is then dissected out of the heel flap from above. In this way the difficulty of dissecting the posterior flap round the heel is avoided.

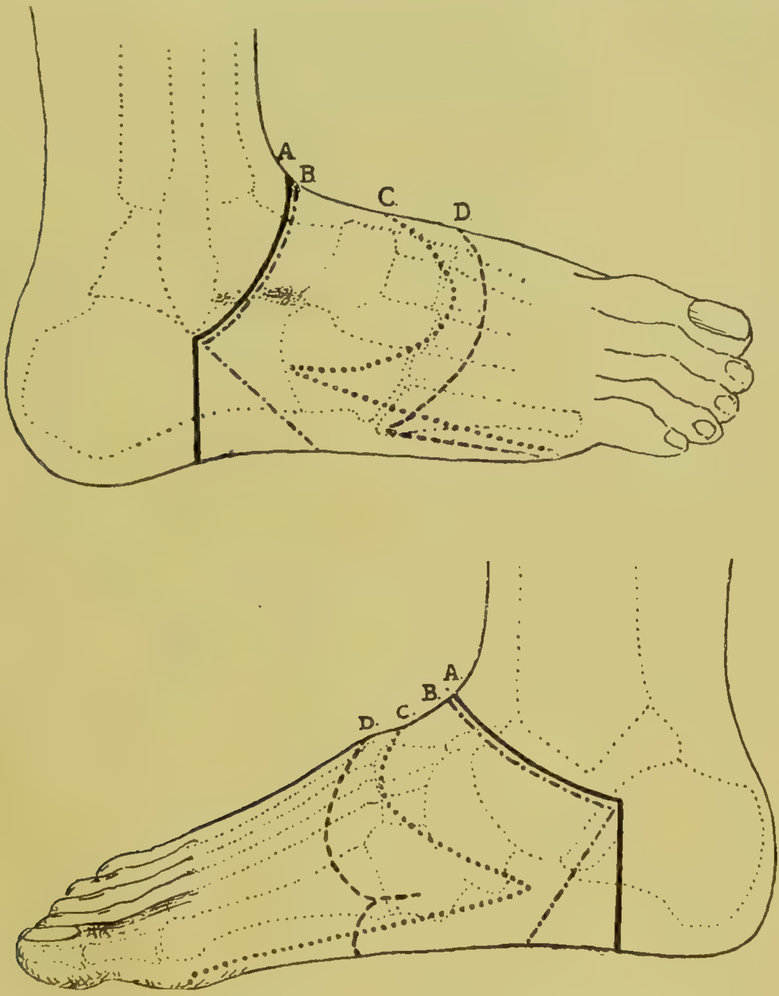

FIG. 439.—Lines of incision in various amputations of the foot. A, Syme's ; B, Pirogoff's ; C, Chopart's ; D, Lisfranc's.

Pirogoff's amputation bears the same relation to Syme's at the ankle as Gritti's does to Carden's at the knee. It consists in removing the whole of the foot except the posterior part of the os calcis at the ankle joint, and then in applying the sawn surface of the portion of the os calcis which is left to the previously sawn ends of the tibia and fibula. The position of the patient and operator is the same as in Syme's amputation, and the incisions begin and end at the same points ; but the plantar incision is not made directly across the foot, but obliquely forwards (fig. 439), and is carried down to the bone in an oblique direction, upwards and backwards ; so that in making the incision the knife must not be held at right angles to the sole. The foot is now extended, and a straight incision is made from the two extremities of the first incision across the front of the ankle. The ankle joint is opened and the lateral ligaments severed. The foot is now further extended, and the upper surface of the os calcis, behind its articular facets, exposed. The assistant firmly grasps the heel, while a narrow saw is introduced and applied to the upper surface of the os calcis, midway between the tendo Achillis and the astragalus, and a section of the bone made in a direction downwards and forwards, care being taken to bring it out through the incision on the sole of the foot. The lower ends of the tibia and fibula are cleared from the soft parts, and a thin slice is removed from the inferior surface of the tibia, as well as the two malleoli. Originally, Pirogoff recommended a vertical section of the os calcis ; and under these circumstances, after union had taken place, the patient walked on the thin skin over the back of the heel, instead of the thick cushion under the tuberosities. After the operation is completed, the heel flap is united to the skin in front, and as a rule it is not necessary to suture the bones, though some surgeons prefer to do so. The patient should be laid on his side, with the knee flexed, so as to relax the tendo Achillis.

Very diverse opinions are held with regard to the merits of Pirogoff's amputation. Some surgeons prefer it to Syme's, while others believe that it is inferior to that operation. It would certainly appear to have two distinct disadvantages. The one is that it is not applicable to cases of tuberculous disease of the tarsus, since a portion of one of these bones is left behind in which the disease may recur ; and, secondly, union may fail to take place between the two bones, and an unstable stump may result.

Sub-astragaloid amputation consists in removal of the whole foot except the astragalus. It is little practised in this country, and the cases suited to it are few in number, since it is not often that disease of the os calcis and other tarsal bones is present without the astragalus being involved. On the Continent it has been practised as a substitute for Chopart's operation. Several methods have been recommended for its performance, of which we have only space to describe one—viz. Faraboeuf's, which appears to be the best, as the nutrition of the flaps is well provided for. An incision is commenced just to the outer side of the tendo Achillis and carried forwards along the outer border of the foot, a finger's breadth below the external malleolus, to the tuberosity of the fifth metatarsal bone. It is then carried upwards and inwards across the dorsum of the foot as far as the tendon of the extensor proprius hallucis, and from that point is made to slope downwards over the inner border of the foot to the centre of the sole, and is then curved backwards and outwards to the point from which the incision started. A large internal and plantar flap is thus formed, which is abundantly supplied with blood. It is dissected up, the astragalo-navicular joint is opened, and by depressing the foot the point of the knife can be introduced between the os calcis and astragalus, and the strong interosseous ligament divided. The tendo Achillis is then divided, and the remaining soft parts separated from the bones, and the foot removed.

Chopart's amputation is an amputation at the mid-tarsal joint, the whole of the bones of the foot being removed except the os calcis and the astragalus. Considerable difference of opinion exists among surgeons as to the value of this operation, some asserting that the results are so bad that the operation ought never to be performed, and others speaking highly of its merits. This is in a great measure to be explained by the fact that the results obtained are very variable. In some cases the patient is able to use his stump almost as a natural foot, with very little alteration in his gait, and in others he is scarcely able to walk at all without pain and lameness. The result in these latter cases is due to the fact that the heel is drawn upwards, and the patient walks on the anterior surface of the os calcis instead of the under surface of the heel. Two causes have been assigned for the drawing up of the heel. One of these is the unbalanced action of the calf muscles ; and in order to prevent this it has been recommended that the tendo Achillis should be divided at the time of the operation, or that the tendons of the extensor muscles which have been divided on the dorsum of the foot should be stitched into the tissues of the sole flap, so as to give them a fixed point from which to counterbalance the tendo Achillis. The other cause of the tilting of the heel is said to be that the arch of the foot is divided in its centre, and the posterior half which is left, having no support, sinks mechanically. Probably both causes have something to do with this condition. Personally, I should not recommend a Chopart's amputation. The results which are obtained by a Syme's amputation properly performed are so uniformly good that I should not consider it advisable to perform a Chopart's operation for the sake of preserving a small portion of the foot, with the uncertainty as to what the result would be. Chopart's amputation is best performed by making a large flap from the sole, and then making a short dorsal flap and disarticulating at the astragalo-navicular and calcaneo-cuboid joints. An incision is first made from just behind the tubercle of the navicular bone, along the inner side of the foot, to the head of the first metatarsal bone ; it is carried obliquely outwards and backwards across the sole of the foot to the head of the fifth metatarsal bone, and is then carried backwards along the outer border of the foot to a point midway between the tuberosity of the fifth metatarsal bone and the tip of the external malleolus. The flap thus formed should be an inch longer on its inner than its outer border, and should be rounded at its angles. This plantar flap is then dissected up, including all the structures down to the bones. The dorsal flap is made by carrying an incision convex forwards, across the dorsum of the foot, from the two ends of the plantar flap. This is raised by dissection, until the joint between the head of the astragalus and the navicular bone is reached. This is opened from above, and the foot being depressed by the left hand of the operator, the ligaments between the os calcis and cuboid are divided and the disarticulation completed. After all bleeding vessels have been tied, the plantar flap is turned upwards over the ends of the astragalus and os calcis and united to the dorsal flap.

Tripier has somewhat modified Chopart's amputation. He recommends that, in addition to removing all the bones of the tarsus except the os calcis and astragalus, the under surface of the os calcis should be removed by cutting horizontally through it at the level of the sustentaculum tali, taking care to make the section at right angles to the leg. This is said to possess all the advantages of Chopart's amputation without its disadvantages, as it leaves a broad flat surface to stand upon, instead of the tuberosities of the os calcis and the unsupported anterior extremity of that bone. The operation is performed by a racquet-shaped incision, which starts from the outer border of the tendo Achillis and passes forwards about an inch below the tip of the external malleolus to the calcaneo-cuboid joint. From the extremity of this an oval incision is carried round the foot. The flaps are retracted, disarticulation at the mid-tarsal joint performed, and the section of the os calcis proceeded with.

Amputation through the tarso-metatarsal joint.—The cases in which this operation can be performed are few : some cases of severe crushing of the toes, and perhaps in frost-bite and perforating ulcer. When it can be performed it leaves a most useful and excellent stump. The operation by which it is done is known as Lisfranc's. The best mode of performing it is to make the dorsal flap first, then the plantar, and finally disarticulate ; but some surgeons prefer to disarticulate before making the plantar flap. An incision is first made across the dorsum of the foot, from the tuberosity of the fifth metatarsal bone to the joint between the first metatarsal and the internal cuneiform bone; that is, an inch in front of the tuberosity of the navicular. The incision should be slightly rounded with its convexity forwards. The plantar flap is now formed by an incision, starting from one extremity of the dorsal incision and running along the border of the foot to the head of the metatarsal bone, then obliquely across the heads of the metatarsal bones, so that the flap shall be a little longer at its inner than its outer border, and along the other side of the foot to the extremity of the dorsal cut. The flap is then dissected up as thickly as possible. Disarticulation is now proceeded with. The surgeon, grasping the anterior part of the foot firmly in his left hand, introduces his knife close behind the tuberosity of the fifth metatarsal bone and opens the joint between the base of this bone and the cuboid by cutting obliquely forwards and inwards, as if he were aiming to cut through the head of the first metatarsal bone; he then inclines his knife a little more inwards, as if aiming for the middle of the first metatarsal bone, and severs the connections between the fourth metatarsal and the cuboid and external cuneiform bones. Turning his knife so as to cut transversely inwards, he divides the ligaments between the third metatarsal bone and the external cuneiform. He now withdraws his knife and attacks the joints from the inner side of the foot, dividing the ligaments which connect the first metatarsal bone to the internal cuneiform. The articulations of the second metatarsal bone now alone require to be dealt with. The fore part of the foot is forcibly depressed, and the point of the knife is inserted on the dorsum of the foot into the joint between the second metatarsal bone and the middle cuneiform. This will be found half an inch behind the level of the internal cuneiform. The joint is thus opened, a touch or two of the knife will divide the remaining connections, and the operation will be completed.

Hey performed a somewhat similar operation to Lisfranc, but disarticulated through the four outer metatarso-tarsal joints, and sawed off the projecting portion of the internal cuneiform. Skey also modified the operation by disarticulating the three outer and the inner joint, and sawing through the second metatarsal bone on a level with the other articulations.

Amputation of the great toe (fig. 440), including its metatarsal bone, is best removed by the 'racquet-shaped incision.' The incision is commenced on the inner side of the dorsum of the foot, half an inch behind the tarso-metatarsal articulation, and is carried along the dorsal aspect of the bone to the level of the web between the first and second toes; it is then continued round the great toe in a circular manner, so that it passes through the point where the web joins the toe on its outer side. The soft parts are to be separated from the bone on its upper, inner, and under surfaces, keeping close to the bone. On the under surface, care must be taken not to leave the sesamoid bones in the flap. The head of the bone is to be seized with a pair of lion forceps, and the knife being inserted round its outer side, the tissues on this surface are carefully separated from the bone until the tarsal end is reached. By now forcibly pulling the bone inwards, the ligaments of the tarso-metatarsal joint are put on the stretch, and a touch or two of the knife completes the amputation.

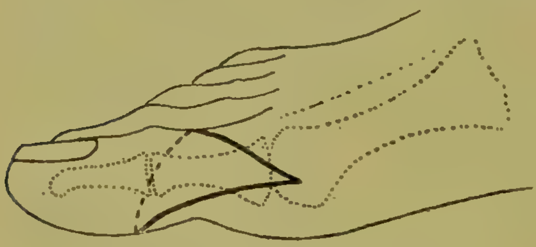

FIG. 440.—Amputation of the big toe at the metatarso-phalangeal joint.

Amputation of the great toe through the metatarso-phalangeal joint is an operation which is much more frequently required than the preceding. It is usually performed by the racquet-shaped incision, and the operation of Farabœuf gives the best results (fig. 440). An incision is commenced over the head of the metatarsal bone, on the inner side of the extensor longus hallucis tendon, and is carried along the inner side of the first phalanx almost to the interphalangeal joint. It is then turned downwards on to the plantar surface, and is carried obliquely backwards and outwards to the web between the first and second toes, and is then brought upwards again on to the dorsal surface, and carried backwards and inwards to join the commencement of the incision. The flaps are dissected back from the bone until the metatarso-phalangeal joint is reached, when the ligaments are divided and the toe removed.

Removal of the little toe, with its metatarsal bone, is conducted on exactly the same lines as the corresponding operation on the great toe, by a racquet-shaped incision.

Amputation of the little toe through the metatarso-phalangeal joint.—This is best done by making a single dorsal and external flap. An incision is commenced on the inner side of and above the head of the metatarsal bone, and carried forwards to the web between the fourth and fifth toes which is divided, but the incision is not carried further than this into the plantar surface of the foot. The flap is dissected outwards, the point of the knife inserted into the joint from above, and disarticulation completed by dividing the lateral ligaments. The bone is then dissected out from its bed in the soft parts.

Amputation of the other toes.—The phalanges of the toes rarely require amputation ; when they do, they can be removed in the same way as the corresponding parts in the hand.

Amputation at the metatarso-phalangeal joint is sometimes required. It should always be done by the oval method, so that the plantar surface of the foot is not opened up. An incision is made on the dorsal surface of the toe, beginning a little behind the head of the metatarsal bone, and carried forwards over the joint to the level of the web of the toes. It is then swept in a circular manner round the toe. The two flaps are dissected back, the joint is opened, its ligaments divided, and the toe removed.

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